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COLUMBIA RIVER BASIN FISH CONTAMINANT SURVEY

VOLUME 1
Appendix O

Summary of Risk Characterization Results for Resident Species

July 2002

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U.S. Environmental Protection Agency
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Appendix O - Summary of Risk Characterization Results for Resident Species

Six species of resident fish were sampled in the Columbia River basin: bridgelip sucker (*Catostomus columbianus*), largescale sucker (*Catostomus macrocheilus*), mountain whitefish (*Prosopium williamsoni*), white sturgeon (*Acipenser transmontanus)*, walleye (*Stizostedion vitreum*), and rainbow trout (*Onchorynchus mykiss*). These fish spend their entire life in freshwater in contrast to anadromous fish species which spend a portion of their lifecycle in the ocean. Specific life history traits for each species are discussed in Appendix B.

The following sections discuss the non-cancer health effects and cancer risk estimates associated with consuming resident fish species for both the general public and for Columbia River Basin Native American[1] populations. The methods used for this risk characterization were discussed in Sections 4 through 6 and a summary of the results are presented in Section 6.

Seventeen health endpoints were assessed for non-cancer health effects (Table 5-3). A total of 45 chemicals were used to generate the health endpoints ranging from one to 17 chemicals per health endpoint. A total hazard index for non-cancer health effects was also evaluated by summing the hazard quotients for individual chemicals. The 56 chemicals that have toxicity values for assessing cancer were evaluated by summing the cancer risk estimates for individual chemicals to determine a total excess cancer risk for two exposure durations: 30 years and 70 years.

Exposure parameters were selected to estimate cancer risk and non-cancer hazards to two target populations referred to as the general public and Columbia River Basin Native Americans (Native Americans) (see Section 4.1). Within each target population, cancer risks and non-cancer hazards were determined for adults, defined as individuals of age 18 or greater; non-cancer hazards were estimated for children, defined as up to age 15 years for the general public and up to age 6 years for Native Americans. Exposure parameters for adults and children differed for the rate of fish consumption, body weight, and exposure duration (Tables 4-1 and 4-2). A summary and discussion of the non-cancer hazards and excess cancer risks for these target populations are presented in this section by species. More detailed information on the risk characterization results are presented in the Appendices for each fish species and tissue type analyzed in this study and for

1. All references to "Native Americans" and "tribes" in this report are only applicable to the CRITFC's member tribes: Confederated Tribes of Warm Springs, Yakama Nation, Umatilla Confederated Tribes, Nez Perce Tribe. They are collectively referred to as the CRITFC's member tribes.

several spatial scales: site, tributary (largescale sucker only), and basin:

- Appendix G1: Hazard quotients for individual chemicals for adults
- Appendix G2: Hazard quotients for individual chemicals for children
- Appendix H1: Percent contribution from individual chemicals to the total hazard index
- Appendix H2: Percent contribution from individual chemicals to endpoint-specific hazard indices
- Appendix I1: Estimated cancer risks for individual chemicals for adults, assuming 30 years exposure
- Appendix I2: Estimated cancer risks for individual chemicals for adults, assuming 70 years exposure
- Appendix J: Percent contribution of individual chemicals to total estimated cancer risk
- Appendix M: Comparison of the total and endpoint specific hazard indices across sites for a CRITFC's member tribal child (high fish consumption rate).
- Appendix N: Cancer risks across a range of consumption rates, by site and species

Appendix O-1 Bridgelip Sucker

Bridgelip sucker were collected from one site in the Columbia River Basin: 48, Yakima River. Chemical analyses were performed on one tissue type, whole body. The risk estimates characterized in this section were based on average chemical concentrations determined from the 3 replicate composite samples collected from Site 48. Because one site was sampled for bridgelip sucker, tributary and basin risk estimates were not calculated.

Noncarcinogenic Health Effects

The potential noncarcinogenic health effects associated with the consumption of whole body bridgelip sucker were assessed by calculating hazard quotients for all detected chemicals with oral reference doses (Appendix G). The hazard quotients of chemicals with the same health endpoint were summed to calculate endpoint-specific hazard indices. In addition, the hazard quotients of all detected chemicals were summed to calculate a total hazard index for the site. Table 1.1 shows the total hazard index for each of the populations evaluated in this risk assessment and the health endpoints which had hazard indices at or above 1.

Table 1.1 Total hazard indices and noncarcinogenic health endpoints with hazard indices at or above 1.0 for bridgelip sucker collected from Site 48, Yakima River

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index
General Public - Adult[a,b]			
AFC	WB	Total HI	0.5
HFC	WB	Liver	2.3
		Immune system	6.1
		Total HI	10
General Public - Child[a,b]			
AFC	WB	Total HI	0.5
HFC	WB	Liver	2.9
		Central nervous system	1.1
		Immune system	7.8
		Total HI	13
Native American - Adult[c,d]			
AFC	WB	Liver	1.0
		Immune system	2.7
		Total HI	4.5

HFC	WB	Liver	6.2
		Central nervous system	2.4
		Immune system	17
		Reproduction/development	1.8
		Total HI	27
Native American - Child[c,d]			
AFC	WB	Liver	1.8
		Immune system	4.9
		Total HI	8.2
HFC	WB	Liver	12
		Cardiovascular	1.0
		Central nervous system	4.8
		Immune system	32
		Reproduction/development	3.4
		Hyperpigmentation/keratosis	1.0
		Total HI	53

NOTE: AFC - average fish consumption HI - hazard index
HFC - high fish consumption WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public (adult) of 7.5 g/day, or 1 8-oz meal per month, and for general public (child) of 2.83 g/day, or 0.4 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month, and for general public (child) of 77.95 g/day, or 11 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month, and for child fish consumers of 24.8 g/day, or 3 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month, and for child fish consumers of 162 g/day, or 22 8-oz meals per month (CRITFC 1994).

Up to six health endpoints exceeded a value of 1.0 in bridgelip sucker, depending on the target population and fish consumption rate used for calculation. The six endpoints were immune system, liver, central nervous system, reproduction/development, cardiovascular, and hyperpigmentation/keratosis, in decreasing order of toxicity.

Noncarcinogenic Chemicals With Hazard Quotients at or Above 1.0

Individual chemicals with a hazard quotient at or above 1.0 in whole body samples of bridgelip sucker at Site 48 were identified and presented in Table 1.2. Hazard quotients for all detected chemicals are presented in Appendix G. A total of five individual chemicals were identified with hazard quotients at or above 1.0 in whole body samples of bridgelip sucker, total Aroclors, total DDT, mercury, manganese, and arsenic, in decreasing order of toxicity based on the Native American child, high fish consumption

rate. Aroclor 1254 and Aroclor 1260 were the only Aroclors detected and used in the total Aroclor calculation.

Table 1.2 Chemicals having hazard quotients at or above 1.0 in bridgelip sucker

ADULTS				CHILDREN			
	HAZARD QUOTIENT		SITES[a] WITH VALUES >1		HAZARD QUOTIENT		SITES[a] WITH VALUES >1
TISSUE TYPE/ CHEMICAL	AFC	HFC	(total # of sites)	TISSUE TYPE/ CHEMICAL	AFC	HFC	(total # of sites)
General Public							
Whole body							
Total	–	6.1	48 (1)	Total	–	7.8	48 (1)
Aroclors				Aroclors			
Total DDT	–	2.1	48 (1)	Total DDT	–	2.7	48 (1)
Native American							
Whole body							
Total	2.7	17	48 (1)	Total	4.9	32	48 (1)
Aroclors				Aroclors			
Total DDT	–	5.9	48 (1)	Total DDT	1.8	11	48 (1)
Mercury	–	1.8	48 (1)	Arsenic	–	1	48 (1)
				Manganese	–	1.4	48 (1)
				Mercury	–	3.4	48 (1)

NOTE: AFC - average fish consumption
HFC - high fish consumption
– - hazard quotient less than 1.0
[a] Site - Waterbody: 48 - Yakima River.

Cancer Risk Estimates

Cancer risks were estimated for general public and Columbia River Basin Native American adults at both 30- and 70-year exposure durations. Appendix I shows the cancer risk estimates for each carcinogenic chemical detected at each site. Total cancer risk estimates for bridgelip sucker are presented in Table 1.3.

Table 1.3 Total excess cancer risk for bridgelip sucker collected from Site 48, Yakima River

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk
General Public[a,b]		
AFC/30-yr	WB	$2x10^{-5}$
HFC/30-yr	WB	$5x10^{-4}$
AFC/70-yr	WB	$6x10^{-5}$
HFC/70-yr	WB	$1x10^{-3}$
Native American[c,d]		
AFC/30-yr	WB	$2x10^{-4}$
HFC/30-yr	WB	$1x10^{-3}$
AFC/70-yr	WB	$5x10^{-4}$
HFC/70-yr	WB	$3x10^{-3}$

NOTE: AFC - average fish consumption WB - whole body
HFC - high fish consumption

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 7.5 g/day, or 1 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month (CRITFC 1994).

Carcinogenic Chemicals with Estimated Excess Cancer Risks At or Above 10^{-5}

Cancer risk estimates vary across populations, consumption rates, and exposure levels by constant factors. Chemicals in bridgelip sucker with cancer risks at or above 1×10^{-5} are shown for the Columbia River Basin Native American population with average fish consumption rates at a 70-year exposure duration; total cancer risk for all chemicals are also shown (Tables 1.4.1 and 1.4.2). Multiplicative factors used to estimate risk at different exposure parameters and target populations are footnoted in the table. In addition, Appendix I shows individual risk estimates for each detected chemical for all the exposure scenarios used in this risk assessment.

The chemicals with cancer risk estimates at or above 1 x 10^{-5} in whole body samples of bridgelip sucker at Site 48 were: adjusted Aroclors; PCBs 118, 126, and 156; 1,2,3,7,8-PeCDD; 2,3,7,8-TCDF; DDD, DDE and DDT; and arsenic.

Table 1.4 Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American population at average fish consumption and 70-year exposure in bridgelip sucker, whole body.

	Bridgelip Sucker Whole Body	
		Site
	Chemical	48
PCBs	Adjusted Aroclors	1E-04
	PCB 118	2E-05
	PCB 126	7E-05
	PCB 156	2E-05
Dioxin/furans	1,2,3,7,8-PeCDD	3E-05
	2,3,7,8-TCDF	1E-05
Pesticides	DDD	2E-05
	DDE	1E-04
	DDT	1E-05
Inorganic	Arsenic	4E-05
	Total cancer risk	**5E-04**

NOTE: To estimate risk levels for general public AFC 30-year exposure, divide the cells in this table by 19.64.
To estimate risk levels for general public HFC 30-year exposure, divide the cells in this table by 1.03.
To estimate risk levels for Native American AFC 30-year exposure, divide the cells in this table by 2.34.
To estimate risk levels for Native American HFC 30-year exposure, divide the cells in this table by 0.38.
To estimate risk levels for general public AFC 70-year exposure, divide the cells in this table by 8.43.
To estimate risk levels for general public HFC 70-year exposure, divide the cells in this table by 0.44.
To estimate risk levels for Native American AFC 70-year exposure, divide the cells in this table by 0.16.

AFC - average fish consumption
HFC - high fish consumption

Appendix O-2 Largescale Sucker

Largescale sucker were collected from seven sites in the Columbia River Basin: 8 and 9U, Columbia River; 13, Snake River; 30, Umatilla River; 48 and 49, Yakima River; and 98, Deschutes River. Chemical analyses were performed on two tissue types—fillet with skin and whole body—except for fish collected from Site 8, where only whole body samples were analyzed. The risk estimates characterized in this section are based on average chemical concentrations determined from three replicate composite samples collected from each site except for Sites 8, 30, and 48. At Site 8, two replicate composites were analyzed; at Site 30, four replicate composites were analyzed for fillet with skin samples; and at Site 48, six replicate composites were analyzed for whole body samples (Appendix A). Data are presented at three spatial scales: site, tributary, and basin. Largescale sucker was the only species collected at replicate sampling sites within a tributary, Site 48 and Site 49 in the Yakima River, and therefore, is the only fish species with tributary risk estimates.

Noncarcinogenic Health Effects

The potential noncarcinogenic health effects associated with the consumption of fillet with skin and whole body largescale sucker were assessed by calculating hazard quotients for all detected chemicals with oral reference doses (Appendix G). The hazard quotients of chemicals with the same health endpoint were summed to calculate endpoint-specific hazard indices. In addition, the hazard quotients of all detected chemicals were summed to calculate a total hazard index for the site, Yakima River tributary, or basin. Samples were collected from two sites in the Yakima River, and, therefore, tributary risk was calculated for the Yakima River only. Table 2.1 shows the total hazard index for each of the target populations evaluated in this risk assessment and the health endpoints which exceeded a value of 1.0.

Table 2.1. Total hazard indices and noncarcinogenic health endpoints with hazard indices at or above 1.0 for largescale sucker

Consumption Rate/ Tissue Type	Health Endpoint	Hazard Index								
		Site[e]							Tributary Average[f]	Basin Average
		8	9U	98	30	13	48	49		
General Public - Adult[a,b]										
AFC FS	Total HI	na	0.7	0.2	0.5	0.4	0.9	0.6	0.7	0.6
AFC WB	Total HI	0.6	1.1	0.4	0.2	0.4	1.1	0.4	0.9	0.7
HFC FS	Liver	na	1.6	–	–	–	2.7	1.5	2.1	1.1

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index								
			Site[e]							Tributary Average[f]	Basin Average
			8	9U	98	30	13	48	49		
		Central nervous system	na	3.8	1.9	5.4	7.4	5.9	4.4	5.2	4.8
		Immune system	na	7.0	1.1	2.5		7.6	4.9	6.3	4.3
		Reproduction/development	na	3.8	1.9	5.4	7.3	5.9	4.4	5.1	4.8
		Total HI	na	13	3.5	8.6	8.2	17	11	14	11
HFC	WB	Liver	1.3	2.8	–	–	–	4.6	1.1	3.4	2.0
		Central nervous system	2.7	2.6	2.5	1.4	4.0	3.4	2.2	3.0	2.8
		Immune system	5.1	13	3.8	1.5	1.2	11	4.3	6.3	6.9
		Reproduction/development	2.6	2.3	2.4	1.2	3.8	3.1	2.0	2.8	2.6
		Total HI	11	20	7.3	3.9	7.1	20	8.3	16	13
General Public - Child[a,b]											
AFC	FS	Total HI	na	0.6	0.2	0.4	0.4	0.8	0.5	0.6	0.5
AFC	WB	Total HI	0.5	0.9	0.3	0.2	0.3	0.9	0.4	0.8	0.6
HFC	FS	Liver	na	2.1	–	–	–	3.5	1.9	2.7	1.4
		Central nervous system	na	4.9	2.4	6.9	9.4	7.6	5.7	6.6	6.2
		Immune system	na	9.0	1.5	3.2	–	9.7	6.3	8.0	5.5
		Reproduction/development	na	4.8	2.4	6.8	9.4	7.5	5.6	6.6	6.1
		Total HI	na	17	4.4	11	10	21	14	18	14
HFC	WB	Liver	1.7	3.5	–	–	–	5.8	1.4	4.4	2.6
		Central nervous system	3.5	3.3	3.2	1.7	5.2	4.3	2.7	3.8	3.6
		Immune system	6.5	16	4.9	1.9	1.5	15	5.5	8.0	8.8
		Metabolism	–	1.0	–	–	–	–	–	–	0.3
		Reproduction/development	3.3	3.0	3.1	1.6	4.9	4.0	2.5	3.5	3.3
		Total HI	14	26	9.3	5.0	9.0	26	11	21	16
Native American - Adult[c,d]											
AFC	FS	Liver	na	–	–	–	–	1.2	–	–	0.5
		Central nervous system	na	1.7	–	2.4	3.3	2.6	2.0	2.3	2.1
		Immune system	na	3.1	–	1.1	–	3.4	2.2	2.8	1.9
		Reproduction/development	na	1.7	–	2.4	3.3	2.6	2.0	2.3	2.1
		Total HI	na	5.8	1.5	3.8	3.6	7.3	4.9	6.1	4.7
AFC	WB	Liver	–	1.2	–	–	–	2.0	–	1.5	0.9
		Central nervous system	1.2	1.2	1.1	–	1.8	1.5	–	1.3	1.2
		Immune system	2.3	5.6	1.7	–	–	5.1	1.9	4.0	3.1
		Reproduction/development	1.2	1.0	1.1	–	1.7	1.4	–	1.2	1.1
		Total HI	4.8	9.1	3.2	1.7	3.1	9.0	3.7	7.2	5.7
HFC	FS	Liver	na	4.5	–	1.1	1.2	7.4	4.1	5.8	3.1
		Central nervous system	na	10	5.2	15	20	16	12	14	13
		Immune system	na	19	3.1	6.9	–	21	13	17	12
		Reproduction/development	na	10	5.1	15	20	16	12	14	13
		Total HI	na	36	9.5	24	22	45	30	38	29
HFC	WB	Liver	3.5	7.5	–	1.0	1.5	12	3.1	9.4	5.5
		Kidney	–	1.2	–	–	–	–	–	–	0.3
		Central nervous system	7.5	7.1	6.9	3.7	11	9.3	5.9	8.1	7.6
		Immune system	14	35	10	4.0	3.1	31	12	25	19
		Metabolism	–	2.2	–	–	–	–	–	–	0.7
		Reproduction/development	7.1	6.4	6.7	3.4	10	8.6	5.4	7.5	7.1
		Gastrointestinal	1.0	–	–	–	–	–	–	–	0.6
		Total HI	29	56	20	11	19	55	23	45	35
Native American - Child[c,d]											
AFC	FS	Liver	na	1.3	–	–	–	2.2	1.2	1.7	0.9
		Central nervous system	na	3.1	1.5	4.4	6.0	4.8	3.6	4.2	3.9
		Immune system	na	5.7	–	2.1	–	6.2	4.0	5.1	3.5

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index								
			Site[e]							Tributary Average[f]	Basin Average
			8	9U	98	30	13	48	49		
		Reproduction/development	na	3.1	1.5	4.4	6.0	4.8	3.6	4.2	3.9
		Total HI	na	11	2.8	7.0	6.6	13	9.0	11	8.6
AFC	WB	Liver	1.1	2.2	–	–	–	3.7	–	2.8	1.6
		Central nervous system	2.2	2.1	2.1	1.1	3.3	2.8	1.7	2.4	2.3
		Immune system	4.1	10	3.1	1.2	–	9.3	3.5	7.4	5.6
		Reproduction/development	2.1	1.9	2.0	–	3.1	2.6	1.6	2.2	2.1
		Total HI	8.7	17	5.9	3.2	5.7	16	6.8	13	10
HFC	FS	Liver	na	8.7	–	2.1	2.3	14	7.9	11	6.0
		Central nervous system	na	20	10	29	39	31	24	28	26
		Immune system	na	37	6.0	13	–	40	26	33	23
		Metabolism	na	1.1	–	–	–	–	–	–	0.8
		Reproduction/development	na	20	9.9	28	39	31	23	27	25
		Gastrointestinal	na	1.3	–	–	–	–	–	–	0.4
		Total HI	na	69	18	46	43	88	59	74	56
HFC	WB	Liver	6.9	15	1.7	2.0	3.0	24	6.0	18	11
		Kidney	1.1	2.3	–	–	–	–	–	–	0.6
		Cardiovascular	1.1	–	–	–	–	–	–	–	0.6
		Central nervous system	15	14	14	7.2	21	18	11	16	15
		Immune system	27	68	20	7.7	6.1	61	23	48	37
		Metabolism	–	4.3	–	–	1.1	1.0	1.1	1.0	1.4
		Reproduction/development	14	12	13	6.5	20	17	10	15	14
		Hyperpigmentation/keratosis	1.1	–	–	–	–	–	–	–	0.6
		Minimal neurotoxicity	1.8	–	–	–	1.3	–	–	–	0.7
		Gastrointestinal	2.0	1.8	–	–	1.6	–	–	–	1.1
		Total HI	57	110	39	21	37	110	44	86	68

NOTE: AFC - average fish consumption
HFC - high fish consumption
HI - hazard index
na - not applicable; sample type not analyzed at this site
– - health endpoint <1.0 at that site
FS - fillet with skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public (adult) of 7.5 g/day, or 1 8-oz meal per month, and for general public (child) of 2.83 g/day, or 0.4 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month, and for general public (child) of 77.95 g/day, or 11 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month, and for child fish consumers of 24.8 g/day, or 3 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month, and for child fish consumers of 162 g/day, or 22 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9U - located in the upper Columbia River above the Snake River; 98 - Deschutes River; 30 - Umatilla River; 13 - Snake River; 48 - Yakima River; 49 - Yakima River.

[f] Tributary risk calculated for Site 48 and Site 49 in the Yakima River.

Up to ten health endpoints exceeded a value of 1.0, depending on the target population and exposure parameters used for calculation. The ten endpoints were immune system, central nervous system, reproduction/development, liver, metabolism, gastrointestinal, minimal neurotoxicity, kidney, cardiovascular, and hyperpigmentation/keratosis, in general decreasing order of toxicity based on basin averages in whole body samples, the tissue type where all ten health endpoints exceeded 1.0. Among specific sampling sites, total hazard indices were lowest at Site 98 in the Deschutes River for Fillet with skin samples and at Site 30 in the Umatilla River for whole body samples. Total hazard indices were highest at Site 48 in the Yakima River for fillet with skin samples and at two sites, 9U in the Columbia River and 48 in the Yakima River for whole body samples. Total hazard indices among sites varied by a factor of 4.8 for fillet with skin samples and 5.2 for whole body samples.

Chemicals With Hazard Quotients At or Above 1.0

Individual chemicals with a hazard quotient at or above 1.0 in fillet with skin samples of largescale sucker collected from six sites and in whole body samples of largescale sucker collected from seven sites were identified and presented in Table 2.2. Hazard quotients for other individual chemicals are presented in Appendix G. A total of four individual chemicals were identified with hazard quotients at or above 1.0 in fillet with skin samples of largescale sucker: total Aroclors, mercury, total DDT, and chromium, in decreasing order of toxicity based on the Native American child high fish consumption rate. A total of ten individual chemicals were identified in whole body samples of largescale sucker: total Aroclors, mercury, total DDT, nickel, cadmium, chromium, aluminum, manganese, zinc, and arsenic, in decreasing order of toxicity based on the Native American child high fish consumption rate. Aroclor 1254 and/or Aroclor 1260 were the only Aroclors detected and used in the total Aroclor calculation.

Table 2.2. Chemicals having hazard quotients at or above 1.0 in largescale sucker

Adults				Children			
Tissue Type/ Chemical	Hazard Quotient AFC	Hazard Quotient HFC	Sites[a] with Values >1 (total # of sites)	Tissue Type/ Chemical	Hazard Quotient AFC	Hazard Quotient HFC	Sites[a] with Values >1 (total # of sites)
General Public							
Fillet with skin							
Total Aroclors	–	1.1-7.0	**9U**,98,30,48,49 (6)	Total Aroclors	–	1.5-9.0	**9U**,98,30,48,49 (6)
Total DDT	–	1.4-2.6	9U,**48**,49 (6)	Total DDT	–	1.8-3.3	9U,**48**,49 (6)
Mercury	–	1.9-7.3	9U,98,30,**13**,48, 49 (6)	Mercury	–	2.4-9.4	9U,98,30,**13**,48, 49 (6)
Whole body							
Total Aroclors	–	1.2-13	8,**9U**,98,30,13,48, 49 (7)	Total Aroclors	–	1.5-16	8,**9U**,98,30,13, 48,49 (7)
Total DDT	–	1.0-4.4	8,9U,**48**,49 (7)	Total DDT	–	1.3-5.6	8,9U,**48**,49 (7)
Mercury	–	1.2-3.8	8,9U,98,30,**13**,48, 49 (7)	Mercury	–	1.6-4.9	8,9U,98,30,**13**, 48, 49 (7)
Native American							
Fillet with skin							
Total Aroclors	1.1-3.4	3.1-21	9U,98a,30,**48**,49 (6)	Total Aroclors	2.1-6.2	6.0-40	9U,98[b],30,**48**,49 (6)
Total DDT	1.1	3.9-7.0	9U[b],**48**,49[b] (6)	Total DDT	1.2-2.1	7.6-14	9U,30[b],13[b],**48,**49 (6)
Mercury	1.7-3.3	5.1-20	9U,98a,30,**13**,48, 49 (6)	Chromium	–	1.3	9U (6)
				Mercury	1.5-6.0	9.9-39	9U,98,30,**13**,48, 49 (6)
Whole body							
Total Aroclors	1.7-5.6	3.1-35	8,**9U**,98,30[b],13[b], 48, 49 (7)	Total Aroclors	1.2-10	6.1-68	8,**9U**,98,30,13[b], 48,49 (7)
Total DDT	1.2-1.9	1.0-12	8a,9U,13[b],**48**,49[b] (7)	Total DDT	1.0-3.5	1.1-23	8,9U,98[b],30[b], 13[b],**48**,49 (7)
Cadmium	–	1.2	9U (7)	Aluminum	–	1.1-1.8	**8**,9U,13 (7)
Chromium	–	1.0	8 (7)	Arsenic	–	1.1	8 (7)
Mercury	1.0-1.7	3.4-10	8,9U,98,30[b],**13**,48,49[b] (7)	Cadmium	–	1.1-2.3	8,**9U** (7)
Nickel	–	1.6	9U (7)	Chromium	–	1.6-2.0	**8**,9U,13 (7)
				Manganese	–	1.3-1.5	**9U**,13,48 (7)
				Mercury	1.0-3.1	6.5-20	8,9U,98,30,**13**, 48, 49 (7)
				Nickel	–	3.0	9U (7)
				Zinc	–	1.3	9U (7)

NOTE: AFC - average fish consumption
HFC - high fish consumption
– - value less than 1.0
Bold indicates site with highest HQ

[a] Site - Waterbody: 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9U - located in the upper Columbia River above the Snake River; 98 - Deschutes River; 30 - Umatilla River; 13 - Snake River; 48 - Yakima River; 49 - Yakima River.

[b] HFC only

Cancer Risk Estimates

Cancer risks were estimated for general public and Columbia River Basin Native American adults at both 30- and 70-year exposure durations. Cancer risk estimates for detected carcinogenic chemicals at each sampling site are presented in Appendix I. Total excess cancer risk estimates are presented in Table 2.3 for each sampling site and for the tributary and basin averages.

Table 2.3. Total excess cancer risk for largescale sucker

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk								
		Site[e]							Tributary Average	Basin Average
		8	9U	98	30	13	48	49		
General Public[a,b]										
AFC/30-yr	**FS**	**na**	**$3x10^{-5}$**	**$7x10^{-6}$**	**$8x10^{-6}$**	**$1x10^{-5}$**	**$2x10^{-5}$**	**$1x10^{-5}$**	**$2x10^{-5}$**	**$2x10^{-5}$**
	WB	**$2x10^{-5}$**	**$5x10^{-5}$**	**$2x10^{-5}$**	**$7x10^{-6}$**	**$6x10^{-6}$**	**$3x10^{-5}$**	**$2x10^{-5}$**	**$3x10^{-5}$**	**$3x10^{-5}$**
HFC/30-yr	**FS**	**na**	**$6x10^{-4}$**	**$1x10^{-4}$**	**$1x10^{-4}$**	**$2x10^{-4}$**	**$4x10^{-4}$**	**$3x10^{-4}$**	**$3x10^{-4}$**	**$4x10^{-4}$**
	WB	**$4x10^{-4}$**	**$1x10^{-3}$**	**$3x10^{-4}$**	**$1x10^{-4}$**	**$1x10^{-4}$**	**$7x10^{-4}$**	**$4x10^{-4}$**	**$6x10^{-4}$**	**$5x10^{-4}$**
AFC/70-yr	**FS**	**na**	**$7x10^{-5}$**	**$2x10^{-5}$**	**$2x10^{-5}$**	**$3x10^{-5}$**	**$5x10^{-5}$**	**$3x10^{-5}$**	**$4x10^{-5}$**	**$5x10^{-5}$**
	WB	**$5x10^{-5}$**	**$1x10^{-4}$**	**$4x10^{-5}$**	**$2x10^{-5}$**	**$1x10^{-5}$**	**$8x10^{-5}$**	**$5x10^{-5}$**	**$7x10^{-5}$**	**$6x10^{-5}$**
HFC/70-yr	**FS**	**na**	**$1x10^{-3}$**	**$3x10^{-4}$**	**$3x10^{-4}$**	**$5x10^{-4}$**	**$1x10^{-3}$**	**$6x10^{-4}$**	**$8x10^{-4}$**	**$9x10^{-4}$**
	WB	**$9x10^{-4}$**	**$2x10^{-3}$**	**$7x10^{-4}$**	**$3x10^{-4}$**	**$3x10^{-4}$**	**$2x10^{-3}$**	**$9x10^{-4}$**	**$1x10^{-3}$**	**$1x10^{-3}$**
Native American[c,d]										
AFC/30-yr	**FS**	**na**	**$3x10^{-4}$**	**$6x10^{-5}$**	**$6x10^{-5}$**	**$1x10^{-4}$**	**$2x10^{-4}$**	**$1x10^{-4}$**	**$2x10^{-4}$**	**$2x10^{-4}$**
	WB	**$2x10^{-4}$**	**$5x10^{-4}$**	**$1x10^{-4}$**	**$6x10^{-5}$**	**$5x10^{-5}$**	**$3x10^{-4}$**	**$2x10^{-4}$**	**$3x10^{-4}$**	**$2x10^{-4}$**
HFC/30-yr	**FS**	**na**	**$2x10^{-3}$**	**$4x10^{-4}$**	**$4x10^{-4}$**	**$6x10^{-4}$**	**$1x10^{-3}$**	**$7x10^{-4}$**	**$9x10^{-4}$**	**$1x10^{-3}$**
	WB	**$1x10^{-3}$**	**$3x10^{-3}$**	**$9x10^{-4}$**	**$3x10^{-4}$**	**$3x10^{-4}$**	**$2x10^{-3}$**	**$1x10^{-3}$**	**$2x10^{-3}$**	**$1x10^{-3}$**
AFC/70-yr	**FS**	**na**	**$6x10^{-4}$**	**$1x10^{-4}$**	**$2x10^{-4}$**	**$2x10^{-4}$**	**$4x10^{-4}$**	**$3x10^{-4}$**	**$4x10^{-4}$**	**$4x10^{-4}$**
	WB	**$4x10^{-4}$**	**$1x10^{-3}$**	**$3x10^{-4}$**	**$1x10^{-4}$**	**$1x10^{-4}$**	**$7x10^{-4}$**	**$4x10^{-4}$**	**$6x10^{-4}$**	**$5x10^{-4}$**
HFC/70-yr	**FS**	**na**	**$4x10^{-3}$**	**$8x10^{-4}$**	**$9x10^{-4}$**	**$1x10^{-3}$**	**$3x10^{-3}$**	**$2x10^{-3}$**	**$2x10^{-3}$**	**$2x10^{-3}$**
	WB	**$3x10^{-3}$**	**$7x10^{-3}$**	**$2x10^{-3}$**	**$8x10^{-4}$**	**$7x10^{-4}$**	**$4x10^{-3}$**	**$2x10^{-3}$**	**$4x10^{-3}$**	**$3x10^{-3}$**

NOTE: **AFC - average fish consumption** **FS - fillet with skin**
HFC - high fish consumption **WB - whole body**
na - not applicable; sample type not analyzed at this site

[a] **AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 7.5 g/day, or 1 8-oz meal per month (USEPA 2000b).**

[b] **HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month (USEPA 2000b).**

[c] **AFC risk based on average consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month (CRITFC 1994).**

[d] **HFC risk based on 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month (CRITFC 1994).**

[e] **Site - Waterbody: 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9U - located in the upper Columbia River above the Snake River; 13 - Snake River; 30 - Umatilla River; 48 - Yakima River; 49 - Yakima River; 98 - Deschutes River; 101 - Umatilla River.**

Carcinogenic Chemicals with Estimated Excess Cancer Risks At or Above 10^{-5}

Cancer risk estimates vary across populations, consumption rates, and exposure levels by constant factors. Chemicals in largescale sucker with cancer risks at or above 1×10^{-5} are shown for the Columbia River Basin Native American population with average fish consumption rates at a 70-year exposure duration; total cancer risk for all chemicals are also shown (Tables 2.4.1 and 2.4.2). Multiplicative factors used to estimate risk at different exposure parameters and target populations are footnoted in the table. In addition, Appendix I shows individual risk estimates for each detected chemical for all the exposure scenarios used in this risk assessment.

Adjusted Aroclors had the highest or second highest risk estimate at all sites in whole body samples and at all sites except Site 13 in fillet with skin samples where dibenz[a,h]anthracene had the highest risk estimate. Aroclor 1254 was the only individual Aroclor detected and used in the adjusted Aroclor calculation at Site 98 in fillet with skin and whole body samples. At Site 30, Aroclor 1260 was the only individual Aroclor detected and used in the adjusted Aroclor calculation in whole body samples. For all other sites with adjusted Aroclors greater than 10^{-5}, both Aroclors 1254 and 1260 were detected and used in the adjusted Aroclor calculation. At Site 48, DDE had the highest risk estimate for both tissue types. Of the PCB congeners, PCB 126 had the highest risk estimate for both tissue types at Site 98, and for fillet with skin samples at Site 9U. At Site 13, in fillet with skin samples, dibenz[a,h]anthracene, PCB 169, and benzo(a)pyrene, had risks greater than 10^{-5} and were not identified at any other sites.

Table 2.4.1. Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American population at average fish consumption and 70-year exposure in largescale sucker, whole body

		Largescale sucker - whole body						
		Site						
	Chemical	8	9U	13	30	48	49	98
PCBs	Adjusted Aroclors	$8x10^{-5}$	$2x10^{-4}$	$2x10^{-5}$	$2x10^{-5}$	$2x10^{-4}$	$7x10^{-5}$	$6x10^{-5}$
	PCB 105	$2x10^{-5}$	$6x10^{-5}$			$1x10^{-5}$	$2x10^{-5}$	$1x10^{-5}$
	PCB 114	-						
	PCB 118	$3x10^{-5}$	$1x10^{-4}$		$1x10^{-5}$	$3x10^{-5}$	$3x10^{-5}$	$3x10^{-5}$
	PCB 126	-	$2x10^{-4}$				$6x10^{-5}$	$1x10^{-4}$
	PCB 156	$3x10^{-5}$	$1x10^{-4}$	$1x10^{-5}$	$1x10^{-5}$	$4x10^{-5}$	$4x10^{-5}$	$3x10^{-5}$
	PCB 157	-	$2x10^{-5}$					
Dioxin/furans	1,2,3,7,8-PeCDD	$1x10^{-3}$			$2x10^{-5}$	$2x10^{-5}$	$2x10^{-5}$	$2x10^{-5}$
	2,3,7,8-TCDD	$3x10^{-5}$					$1x10^{-5}$	
	2,3,7,8-TCDF	$5x10^{-5}$	$3x10^{-5}$	-	-		-	-
Pesticide	DDD	$1x10^{-5}$	$1x10^{-5}$	-	-	$2x10^{-5}$	-	-
	DDE	$8x10^{-5}$	$2x10^{-4}$	$2x10^{-5}$	$1x10^{-5}$	$3x10^{-5}$	$6x10^{-5}$	$1x10^{-5}$
	DDT	-	-	-	-	$3x10^{-4}$	$1x10^{-5}$	-
Inorganic	Arsenic	$4x10^{-5}$	$3x10^{-5}$	$3x10^{-5}$	$2x10^{-5}$	$1x10^{-5}$	$1x10^{-5}$	$2x10^{-5}$
Semivolatiles	1,2-Diphenylhydrazine	-	-	-	-	-	$4x10^{-5}$	-
	Total Cancer Risk	$4x10^{-4}$	$1x10^{-3}$	$1x10^{-4}$	$1x10^{-4}$	$7x10^{-4}$	$4x10^{-4}$	$3x10^{-4}$

Table 2.4.2. Chemicals with cancer risks greater at or above 1 x 10^{-5} for Columbia River Basin Native American population at average fish consumption and 70-year exposure in largescale sucker fillet with skin

		Largescale Sucker-Fillet w-skin					
		Site					
	Chemical	9U	13	30	48	49	98
PCBs	**Adjusted Aroclors**	1E-04		4E-05	1E-04	9E-05	2E-05
	PCB 105	3E-05					
	PCB 114	1E-05					
	PCB 118	7E-05		1E-05	2E-05	1E-05	1E-05
	PCB 126	1E-04				2E-05	4E-05
	PCB 156	8E-05		1E-05	3E-05	1E-05	1E-05
	PCB 157	1E-05					
	PCB 169		4E-05				
Dioxin/furans	**1,2,3,7,8-PeCDD**			2E-05		1E-05	
	2,3,7,8-TCDF	2E-05					
Pesticides	**DDE**	1E-04	2E-05	2E-05	2E-04	9E-05	
	DDT				2E-05	1E-05	
Inorganic	**Arsenic**		1E-05	1E-05			1E-05
Semivolatiles	**Dibenz[a,h]anthracene**		9E-05				

Benzo(a)pyrene		3E-05				
Total Cancer Risk for All Chemicals	6E-04	2E-04	2E-04	4E-04	3E-04	2E-04

NOTE: A blank indicates that this chemical does not have a cancer risk greater than 1 x 10^{-5} for this tissue type at this site

To estimate risk levels for general public AFC 30-year exposure, divide the cells in this table by 19.64.

To estimate risk levels for general public HFC 30-year exposure, divide the cells in this table by 1.03.

To estimate risk levels for Native American AFC 30-year exposure, divide the cells in this table by 2.34.

To estimate risk levels for Native American HFC 30-year exposure, divide the cells in this table by 0.38.

To estimate risk levels for general public AFC 70-year exposure, divide the cells in this table by 8.43.

To estimate risk levels for general public HFC 70-year exposure, divide the cells in this table by 0.44.

To estimate risk levels for Native American AFC 70-year exposure, divide the cells in this table by 0.16.

[a] Site - Waterbody: 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9U - located in the upper Columbia River above the Snake River; 13 - Snake River; 30 - Umatilla River; 48 - Yakima River; 49 - Yakima River; 98 - Deschutes River

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AFC - average fish consumption
HFC - high fish consumption

Appendix O-3 Mountain Whitefish

Mountain whitefish were collected from four sites in the Columbia River Basin: 9U, Columbia River; 48, Yakima River; 98, Deschutes River; and 101, Umatilla River. Chemical analyses were performed on both fillet with skin and whole body tissue types. The cancer risk and non-cancer hazards in this section are based on average chemical concentrations determined from 3 replicate composite samples collected from each site (Appendix A). Data are presented at two spatial scales: site and basin. Mountain whitefish were not collected from replicate sampling sites within a tributary and, therefore, tributary risk estimates were not calculated.

Noncarcinogenic Health Effects

The potential noncarcinogenic health effects associated with the consumption of fillet with skin and whole body mountain whitefish were assessed by calculating hazard quotients for all detected chemicals with oral reference doses (Appendix G). The hazard quotients of chemicals with the same health endpoint were summed to calculate endpoint-specific hazard indices. In addition, the hazard quotients of all detected chemicals were summed to calculate a total hazard index for the site or basin. Table 3.1 shows the total hazard index for each of the target populations evaluated in this risk assessment and the health endpoints which are at or above a hazard index of 1.0.

Table 3.1 Total hazard indices and noncarcinogenic health endpoints with hazard indices at or above 1.0 for mountain whitefish

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index: Site[e] 9U	98	101	48	Basin Average
General Public - Adult[a,b]							
AFC	FS	Immune system	2.7	–	–	1.0	1.0
		Total HI	2.9	0.3	0.2	1.4	1.2
AFC	WB	Immune system	1.2	–	–	–	0.6
		Total HI	1.4	0.4	0.3	1.1	0.8
HFC	FS	Liver	3.7	–	–	3.9	2.1
		Central nervous system	–	1.6	1.2	2.6	1.6
		Immune system	50	2.7	1.4	20	20
		Reproduction/development	–	1.6	1.2	2.6	1.6
		Total HI	55	4.7	3.2	26	24
HFC	WB	Liver	3.8	–	–	3.6	2.1
		Central nervous system	–	1.6	1.1	1.9	1.5
		Immune system	23	4.3	2.8	15	11
		Reproduction/development	–	1.5	1.1	1.9	1.4
		Total HI	27	6.9	5.1	21	16
General Public - Child[a,b]							
AFC	FS	Immune system	2.3	–	–	–	0.9
		Total HI	2.5	0.2	0.1	1.2	1.1
AFC	WB	Immune system	1.1	–	–	–	0.5
		Total HI	1.3	0.3	0.2	1.0	0.7
HFC	FS	Liver	4.7	–	–	5.0	2.7
		Central nervous system	–	2.1	1.6	3.4	2.1
		Immune system	64	3.5	1.7	25	25
		Reproduction/development	–	2.1	1.6	3.4	2.1

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index: Site[e] 9U	98	101	48	Basin Average
		Total HI	70	6.1	4.1	34	30
HFC	WB	Liver	4.9	–	–	4.6	2.6
		Central nervous system	–	2.0	1.4	2.5	1.9
		Immune system	29	5.5	3.6	19	15
		Reproduction/development	–	1.9	1.3	2.4	1.8
		Total HI	35	8.8	6.5	27	20
Native American - Adult[c,d]							
AFC	FS	Liver	1.6	–	–	1.7	0.9
		Central nervous system	–	–	–	1.2	0.7
		Immune system	22	1.2	–	8.7	8.7
		Reproduction/development	–	–	–	1.2	0.7
		Total HI	24	2.1	1.4	12	11
AFC	WB	Liver	1.7	–	–	1.6	0.9
		Immune system	10	1.9	1.2	6.6	5.1
		Total HI	12	3.1	2.3	9.3	6.9
HFC	FS	Liver	11	–	–	11	5.7
		Central nervous system	–	4.5	3.4	7.2	4.5
		Immune system	140	7.4	3.7	53	54
		Reproduction/development	–	4.5	3.4	7.2	4.4
		Total HI	150	13	8.8	72	65
HFC	WB	Liver	10	–	1.9	9.8	5.6
		Central nervous system	–	4.3	3.1	5.3	4.0
		Immune system	63	12	7.6	41	31
		Reproduction/development	–	4.1	2.9	5.1	3.8
		Selenosis	1.2	–	1.3	1.1	1.1
		Total HI	75	19	14	57	42
Native American - Child[c,d]							
AFC	FS	Liver	3.0	–	–	3.2	1.7
		Central nervous system	–	1.3	1.0	2.2	1.3
		Immune system	41	2.2	1.1	16	16
		Reproduction/development	–	1.3	–	2.1	1.3
		Total HI	44	3.9	2.6	21	19
AFC	WB	Liver	3.1	–	–	2.9	1.7
		Central nervous system	–	1.3	–	1.6	1.2
		Immune system	19	3.5	2.3	12	9.3
		Reproduction/development	–	1.2	–	1.5	1.1
		Total HI	22	5.6	4.2	17	13
HFC	FS	Liver	20	–	1.7	21	11
		Central nervous system	–	8.7	6.6	14	8.7
		Immune system	270	14	7.2	100	100
		Reproduction/development	–	8.7	6.5	14	8.6
		Selenosis	1.0	–	1.1	1.5	1.1
		Gastrointestinal	1.2	–	–	–	0.5

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index: Site[e] 9U	98	101	48	Basin Average
		Total HI	290	25	17	140	130
HFC	WB	Liver	20	1.7	3.8	19	11
		Central nervous system		8.3	5.9	10	7.8
		Immune system	120	23	15	79	61
		Metabolism	–	1.6	1.0	–	1.2
		Reproduction/development	–	8.0	5.6	9.9	7.4
		Selenosis	2.3	1.4	2.5	2.2	2.1
		Total HI	150	37	27	110	83

NOTE: AFC - average fish consumption
HFC - high fish consumption
HI - hazard index
– - health endpoint <1.0 at that site
FS - fillet with skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public (adult) of 7.5 g/day, or 1 8-oz meal per month, and for general public (child) of 2.83 g/day, or 0.4 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month, and for general public (child) of 77.95 g/day, or 11 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month, and for child fish consumers of 24.8 g/day, or 3 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month, and for child fish consumers of 162 g/day, or 22 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 9U - located in the upper Columbia River above the Snake River; 98 - Deschutes River; 101 - Umatilla River; 48 - Yakima River.

Up to seven health endpoints were at or above a value of 1.0, depending on the target population and exposure parameters used for calculation. The seven endpoints were immune system, liver, central nervous system, reproduction/development, selenosis, metabolism, and gastrointestinal in decreasing order of toxicity based on basin average total hazard indices of whole body samples. The immune system endpoint exceeded 1.0

for each target population and exposure scenario. The gastrointestinal health endpoint was unique to fillet with skin samples. Among specific sampling sites, total hazard indices for both fillet with skin and whole body samples were lowest at Site 101 in the Umatilla River and Site 98 in the Deschutes River and were generally an order of magnitude higher at Site 48 in the Yakima River and Site 9U in the Columbia River. Total hazard indices among sample sites varied by a factor of 17 in fillet with skin samples and by 5 in whole body samples.

Chemicals With Hazard Quotients At or Above 1.0

Individual chemicals with a hazard quotient at or above 1.0 in fillet with skin and whole body samples of mountain whitefish collected from four sites were identified and are presented in Table 3.2. Hazard quotients for other individual chemicals are presented in Appendix G. A total of four individual chemicals were identified with hazard quotients at or above 1.0 in fillet with skin samples of mountain whitefish: total Aroclors, total DDT, mercury, and selenium, in decreasing order of toxicity based on the Native American child, high fish ingestion rate. A total of five individual chemicals were identified with hazard quotients at or above 1.0 in whole body samples of mountain whitefish: total Aroclors, total DDT, mercury, selenium, and zinc, in decreasing order of toxicity based on the Native American child, high fish ingestion rate. Total Aroclors were comprised of Aroclor 1242, Aroclor 1254 and/or Aroclor 1260, depending on the sampling site.

Table 3.2 Chemicals having hazard quotients at or above 1.0 in mountain whitefish

ADULTS				CHILDREN			
TISSUE TYPE/ CHEMICAL	HAZARD QUOTIENT AFC	HAZARD QUOTIENT HFC	SITES[a] WITH VALUES >1 (total # of sites)	TISSUE TYPE/ CHEMICAL	HAZARD QUOTIENT AFC	HAZARD QUOTIENT HFC	SITES[a] WITH VALUES >1 (total # of sites)
General Public							
Fillet with skin							
Total Aroclors	1.0-2.7	1.4-50	**9U**,98[b],101[b],48 (4)	Total Aroclors	2.3	1.7-64	**9U**,98[b],101[b],48[b] (4)
Total DDT	–	3.2-3.5	**9U**,48 (4)	Total DDT	–	4.1-4.5	9U,**48** (4)
Mercury	–	1.2-2.6	98,101,**48** (4)	Mercury	–	1.6-3.4	98,101,**48** (4)
Whole body							
Total Aroclors	1.2	2.8-23	**9U**,98[b],101[b],48[b] (4)	Total Aroclors	1.1	3.6-29	**9U**,98[b],101[b],48[b] (4)
Total DDT	–	3.1	9U,48 (4)	Total DDT	–	4.0	9U,48 (4)
Mercury	–	1.1-1.9	98,101,**48** (4)	Mercury	–	1.3-2.4	98,101,**48** (4)
Native American							
Fillet with skin							
Total Aroclors	1.2-22	3.7-140	**9U**,98,101[b],48 (4)	Total Aroclors	1.1-41	7.2-270	**9U**,98,101,48 (4)
Total DDT	1.4-1.6	8.7-9.6	9U,**48** (4)	Total DDT	2.6-2.9	17-19	9U,**48** (4)

Mercury	1.2	3.4-7.2	98[b],101[b],**48** (4)	Mercury	1.0-2.1	6.5-14	98,101,**48** (4)
				Selenium	–	1.0-1.5	9U,101,48 (4)
Whole body							
Total Aroclors	1.2-10	7.6-63	**9U**,98,101[b],48 (4)	Total Aroclors	2.3-19	15-120	**9U**,98,101,48 (4)
Total DDT	1.4	8.6	9U,48 (4)	Total DDT	2.6	1.1-17	**9U**,101[b],**48** (4)
Mercury	–	2.9-5.1	98,101,**48** (4)	Mercury	1.2-1.5	5.6-9.9	98,101[b],**48** (4)
Selenium	–	1.1-1.3	9U,**101**,48 (4)	Selenium	–	1.4-2.5	9U,98,**101**,48 (4)
				Zinc	–	1.3	98 (4)

NOTE: AFC - average fish consumption
HFC - high fish consumption
– - value less than 1.0
Bold indicates site with highest HQ

[a] Site - Waterbody: 9U - located in the upper Columbia River above the Snake River; 98 - Deschutes River; 101 - Umatilla River; 48 - Yakima River.

[b] HFC only

Cancer Risk Estimates

Cancer risks were estimated for general public and Columbia River Basin Native American adults at both 30- and 70-year exposure durations. Cancer risk estimates for detected carcinogenic chemicals at each sampling site are presented in Appendix I. Total cancer risk estimates are presented in Table 3.3 for each sampling site and for the basin average. Sampling sites were not replicated within a tributary and, therefore, tributary risk estimates were not calculated for mountain whitefish.

Table 3.3 Total excess cancer risks for mountain whitefish

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk				
		Site[e]				Basin Average
		9 U	48	98	101	
General Public[a,b]						
AFC/30-yr	**FS**	$2x10^{-4}$	$6x10^{-5}$	$1x10^{-5}$	$6x10^{-6}$	$7x10^{-5}$
	WB	$8x10^{-5}$	$6x10^{-5}$	$2x10^{-5}$	$9x10^{-6}$	$4x10^{-5}$
HFC/30-yr	**FS**	$4x10^{-3}$	$1x10^{-3}$	$3x10^{-4}$	$1x10^{-4}$	$1x10^{-3}$
	WB	$1x10^{-3}$	$1x10^{-3}$	$4x10^{-4}$	$2x10^{-4}$	$7x10^{-4}$
AFC/70-yr	**FS**	$5x10^{-4}$	$1x10^{-4}$	$3x10^{-5}$	$1x10^{-5}$	$2x10^{-4}$
	WB	$2x10^{-4}$	$1x10^{-4}$	$4x10^{-5}$	$2x10^{-5}$	$9x10^{-5}$
HFC/70-yr	**FS**	$9x10^{-3}$	$2x10^{-3}$	$6x10^{-4}$	$2x10^{-4}$	$3x10^{-3}$
	WB	$3x10^{-3}$	$2x10^{-3}$	$8x10^{-4}$	$4x10^{-4}$	$2x10^{-3}$
Native American[c,d]						
AFC/30-yr	**FS**	$2x10^{-3}$	$5x10^{-4}$	$1x10^{-4}$	$5x10^{-5}$	$6x10^{-4}$
	WB	$7x10^{-4}$	$5x10^{-4}$	$2x10^{-4}$	$8x10^{-5}$	$3x10^{-4}$
HFC/30-yr	**FS**	$1x10^{-2}$	$3x10^{-3}$	$7x10^{-4}$	$3x10^{-4}$	$4x10^{-3}$

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk				
		Site[e]				Basin Average
		9 U	48	98	101	
AFC/70-yr	WB	$4x10^{-3}$	$3x10^{-3}$	$1x10^{-3}$	$5x10^{-4}$	$2x10^{-3}$
	FS	$4x10^{-3}$	$1x10^{-3}$	$3x10^{-4}$	$1x10^{-4}$	$1x10^{-3}$
HFC/70-yr	WB	$2x10^{-3}$	$1x10^{-3}$	$4x10^{-4}$	$2x10^{-4}$	$8x10^{-4}$
	FS	$2x10^{-2}$	$7x10^{-3}$	$2x10^{-3}$	$7x10^{-4}$	$8x10^{-3}$
	WB	$9x10^{-3}$	$7x10^{-3}$	$2x10^{-3}$	$1x10^{-3}$	$5x10^{-3}$

NOTE: AFC - average fish consumption
HFC - high fish consumption
FS - fillet with skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 7.5 g/day, or 1 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 9U - located in the upper Columbia River above the Snake River; 48 - Yakima River; 98 - Deschutes River; 101 - Umatilla River.

Carcinogenic Chemicals with Estimated Risks At or Above 10^{-5}

Cancer risk estimates vary across populations, consumption rates, and exposure levels by constant factors. Chemicals in whitefish with cancer risks at or above 1×10^{-5} are shown for the Columbia River Basin Native American population with average fish consumption rates at a 70-year exposure duration; total cancer risk for all chemicals are also shown (Tables 3.4.1 and 3.4.2). Multiplicative factors used to estimate risk at different exposure parameters and target populations are footnoted in the table. In addition, Appendix I shows individual risk estimates for each detected chemical for all the exposure scenarios used in this risk assessment.

Adjusted Aroclors had the highest or second highest risk estimate for all sites and tissue types. Adjusted Aroclors were composed of different Aroclors at each site: 1254 and 1260 at Site 48; 1254 at Site 98; 1260 at Site 101; and 1242, 1254, and 1260 at Site 9U. PCB 126 had the highest risk estimate for both tissue types at Site 98, and for fillet with skin samples at Site 9U. The remaining chemicals varied among sites and tissue types.

Table 3.4.1 Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American adult, at average fish consumption, and 70-year exposure for mountain whitefish, whole body

		Mountain Whitefish - Whole body			
		Site			
	Chemical	9U	48	98	101
PCBs	Adjusted Aroclors	4E-04	2E-04	7E-05	5E-05
	PCB 105	8E-05	5E-05	2E-05	
	PCB 114	4E-05			
	PCB 118	1E-04	1E-04	3E-05	1E-05
	PCB 126	2E-04	1E-04	1E-04	
	PCB 156	2E-04	1E-04	3E-05	1E-05
	PCB 157	3E-05			
Dioxin/furans	1,2,3,7,8-PeCDD	2E-05	2E-05	2E-05	3E-05
	2,3,4,7,8-PeCDF	2E-05	2E-05		
	2,3,7,8-TCDD	2E-05	3E-05		
	2,3,7,8-TCDF	1E-04	8E-05	2E-05	
Pesticides	DDD	3E-05	1E-05		
	DDE	2E-04	2E-04		1E-05
	DDT		1E-05		
	Aldrin	3E-05			
Inorganic	Arsenic	2E-05	2E0-5	2E-05	2E-05
	Total Cancer Risk for All Chemicals	**2E-03**	**1E-03**	**4E-04**	**2E-04**

Table 3.4.2 Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American adults at average fish consumption and 70-year exposure duration for mountain whitefish, fillet with skin

		Mountain Whitefish - Fillet w-skin			
		Site			
	Chemical	9U	48	98	101
PCBs	Adjusted Aroclors	7E-04	3E-04	4E-05	2E-05
	PCB 105	3E-04	4E-05	1E-05	
	PCB 114	1E-04	2E-05		
	PCB 118	7E-04	9E-05	3E-05	
	PCB 123	1E-05			
	PCB 126	8E-04	1E-04	8E-05	
	PCB 156	5E-04	1E-04	3E-05	
	PCB 157	1E-04	2E-05		
Dioxin/furans	1,2,3,7,8-PeCDD	2E-05	2E-05	3E-05	2E-05
	2,3,4,7,8-PeCDF	2E-05			
	2,3,7,8-TCDD	3E-05	2E-05		
	2,3,7,8-TCDF	2E-04	5E-05		
Pesticides	DDD	2E-05	1E-05		
	DDE	2E-04	2E-04		
	DDT		2E-05		
	Aldrin	4E-05			
Inorganic	Arsenic	2E-05	2E-05		1E-05
	Total Cancer Risk for All Chemicals	4E-03	1E-03	3E-04	1E-04

NOTE: A blank indicates that this chemical does not have a cancer risk greater than 1x10^{-5} for this tissue type at this site.

To estimate risk levels for general public AFC 30-year exposure, divide the cells in this table by 19.64.
To estimate risk levels for general public HFC 30-year exposure, divide the cells in this table by 1.03.
To estimate risk levels for Native American AFC 30-year exposure, divide the cells in this table by 2.34.
To estimate risk levels for Native American HFC 30-year exposure, divide the cells in this table by 0.38.
To estimate risk levels for general public AFC 70-year exposure, divide the cells in this table by 8.43.
To estimate risk levels for general public HFC 70-year exposure, divide the cells in this table by 0.44.
To estimate risk levels for Native American AFC 70-year exposure, divide the cells in this table by 0.16.

AFC = average fish consumption

HFC = high fish consumption

[a] Site - Waterbody: 9U - located in the upper Columbia River above the Snake River; 48 - Yakima River; 98 - Deschutes River; 101 - Umatilla River.

Appendix O-4 White Sturgeon

White sturgeon were collected from six sites in the Columbia River Basin: 6, 7, 8, 9L, and 9U in the Columbia River and Site 13 in the Snake River. Chemical analyses were performed on two tissue types, fillet without skin and whole body. Fillet without skin samples were analyzed for each of the six sampling sites; whole body samples were analyzed for sites 8, 9L, and 9U. The risk estimates characterized in this section are based on average chemical concentrations determined from 3 replicate composite samples collected from each site except for Site 9U, which had 1 composite for fillet without skin samples and 5 replicate composites for whole body samples, and for Site 13, which had 4 replicate composites for fillet without skin samples (Appendix A). Data are presented at two spatial scales: site and basin. White sturgeon were not collected from replicate sampling sites within a tributary and, therefore, tributary risk estimates were not calculated.

Noncarcinogenic Health Effects

The potential noncarcinogenic health effects associated with the consumption of fillet without skin and whole body white sturgeon were assessed by calculating hazard quotients for all detected chemicals with oral reference doses (Appendix G). The hazard quotients of chemicals with the same health endpoint were summed to calculate endpoint-specific hazard indices. In addition, the hazard quotients of all detected chemicals were summed to calculate a total hazard index for the site or basin. Table 4.1 shows the total hazard index for each of the target populations evaluated in this risk assessment and the health endpoints which had hazard indices at or above 1.0.

Table 4.1 Total hazard indices and noncarcinogenic health endpoints with hazard indices at or above 1.0 for white sturgeon

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index						
			Site[e]						Basin
			6	7	8	9L	9U	13	Average
General Public - Adult[a,b]									
AFC	FW	Immune system	–	–	–	–	2.1	–	0.6
		Total HI	0.8	0.6	0.6	1.2	2.9	0.9	0.9
AFC	WB	Immune system	na	na	1.1	–	–	na	0.9
		Total HI	na	na	1.5	1.0	1.2	na	1.3
HFC	FW	Liver	2.3	2.1	2.2	4.0	7.7	2.5	3.1
		Central nervous system	2.4	2.2	1.0	2.2	7.3	6.2	3.1
		Immune system	9.9	5.9	7.1	16	40	7.9	11
		Reproduction/development	2.4	2.2	1.0	2.2	7.3	6.2	3.1
		Total HI	15	11	11	23	55	17	18
HFC	WB	Liver	na	na	4.0	3.2	3.8	na	3.8
		Central nervous system	na	na	3.5	2.7	1.9	na	2.8
		Immune system	na	na	20	13	16	na	17
		Reproduction/development	na	na	3.5	2.6	1.9	na	2.7
		Total HI	na	na	29	20	23	na	24
General Public - Child[a,b]									
AFC	FW	Immune system	–	–	–	–	1.8	–	0.5
		Total HI	0.7	0.5	0.5	1.1	2.6	0.8	0.8
AFC	WB	Total HI	na	na	1.3	0.9	1.1	na	1.1
HFC	FW	Liver	2.9	2.6	2.8	5.1	9.8	3.2	4.0
		Central nervous system	3.1	2.9	1.3	2.8	9.4	7.9	4.0
		Immune system	13	7.6	9.1	21	51	10	14
		Reproduction/development	3.1	2.9	1.3	2.8	9.4	7.9	4.0
		Total HI	19	14	14	29	70	22	23
HFC	WB	Liver	na	na	5.1	4.1	4.9	na	4.9
		Central nervous system	na	na	4.5	3.4	2.4	na	3.9
		Immune system	na	na	26	16	21	na	22
		Reproduction/development	na	na	4.4	3.3	2.4	na	3.8
		Total HI	na	na	37	25	29	na	31
Native American - Adult[c,d]									
AFC	FW	Liver	1.0	–	–	1.8	3.4	1.1	1.4
		Central nervous system	1.1	–	–	–	3.3	2.8	1.4
		Immune system	4.4	2.6	3.1	7.2	18	3.5	5.0
		Reproduction/development	1.1	–	–	–	3.3	2.8	1.4
		Total HI	6.6	4.7	4.7	10	24	7.5	7.9
AFC	WB	Liver	na	na	1.8	1.4	1.7	na	1.7
		Central nervous system	na	na	1.6	1.2	–	na	1.2
		Immune system	na	na	9.0	5.7	7.3	na	7.4
		Reproduction/development	na	na	1.5	1.2	–	na	1.2

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index						
			Site[e]						Basin
			6	7	8	9L	9U	13	Average
		Total HI	**na**	**na**	**13**	**8.8**	**10**	**na**	**11**
HFC	**FW**	**Liver**	**6.2**	**5.6**	**6.1**	**11**	**21**	**6.8**	**8.5**
		Central nervous system	**6.6**	**6.1**	**2.8**	**6.0**	**20**	**17**	**8.5**
		Immune system	**27**	**16**	**19**	**44**	**108**	**22**	**31**
		Reproduction/development	**6.6**	**6.1**	**2.8**	**6.0**	**20**	**17**	**8.5**
		Selenosis	**–**	**1.3**	**1.5**	**2.0**	**–**	**–**	**1.2**
		Total HI	**40**	**29**	**29**	**62**	**150**	**46**	**49**
HFC	**WB**	**Liver**	**na**	**na**	**11**	**8.8**	**10**	**na**	**10**
		Central nervous system	**na**	**na**	**9.6**	**7.2**	**5.1**	**na**	**7.6**
		Immune system	**na**	**na**	**56**	**35**	**45**	**na**	**45**
		Reproduction/development	**na**	**na**	**9.5**	**7.1**	**5.1**	**na**	**7.5**
		Total HI	**na**	**na**	**79**	**54**	**62**	**na**	**66**
Native American - Child[c,d]									
AFC	**FW**	**Liver**	**1.8**	**1.7**	**1.8**	**3.2**	**6.2**	**2.0**	**2.5**
		Central nervous system	**2.0**	**1.8**	**–**	**1.8**	**6.0**	**5.1**	**2.5**
		Immune system	**8.0**	**4.8**	**5.8**	**13**	**32**	**6.4**	**9.2**
		Reproduction/development	**2.0**	**1.8**	**–**	**1.8**	**6.0**	**5.1**	**2.5**
		Total HI	**12**	**8.6**	**8.6**	**18**	**45**	**14**	**14**
AFC	**WB**	**Liver**	**na**	**na**	**3.2**	**2.6**	**3.1**	**na**	**3.1**
		Central nervous system	**na**	**na**	**2.9**	**2.2**	**1.5**	**na**	**2.5**
		Immune system	**na**	**na**	**17**	**10**	**13**	**na**	**14**
		Reproduction/development	**na**	**na**	**2.8**	**2.1**	**1.5**	**na**	**2.4**
		Total HI	**na**	**na**	**24**	**16**	**18**	**na**	**20**
HFC	**FW**	**Liver**	**12**	**11**	**12**	**21**	**41**	**13**	**16**
		Cardiovascular	**1.1**	**1.2**	**1.2**	**1.2**			**1.1**
		Central nervous system	**13**	**12**	**5.5**	**12**	**39**	**33**	**16**
		Immune system	**52**	**32**	**38**	**86**	**210**	**42**	**60**
		Reproduction/development	**13**	**12**	**5.5**	**12**	**39**	**33**	**16**
		Hyperpigmentation/keratosis	**1.1**	**1.2**	**1.2**	**1.2**	**–**	**–**	**1.1**
		Selenosis	**–**	**2.6**	**2.9**	**3.8**	**1.4**	**1.5**	**2.3**
		Total HI	**79**	**56**	**56**	**120**	**290**	**89**	**94**
HFC	**WB**	**Liver**	**na**	**na**	**21**	**17**	**20**	**na**	**20**
		Cardiovascular	**na**	**na**	**1.8**	**1.1**	**1.0**	**na**	**1.4**
		Central nervous system	**na**	**na**	**19**	**14**	**10**	**na**	**16**
		Immune system	**na**	**na**	**110**	**69**	**87**	**na**	**91**
		Reproduction/development	**na**	**na**	**18**	**14**	**9.9**	**na**	**16**
		Hyperpigmentation/keratosis	**na**	**na**	**1.8**	**1.1**	**1.0**	**na**	**1.4**
		Selenosis	**na**	**na**	**1.1**	**1.7**	**1.4**	**na**	**1.3**
		Gastrointestinal	**na**	**na**	**1.1**	**1.8**	**–**	**na**	**1.1**
		Total HI	**na**	**na**	**150**	**110**	**120**	**na**	**130**

NOTE: AFC - average fish consumption
HFC - high fish consumption
HI - hazard index
na - not applicable; sample type not analyzed at this site
– - health endpoint <1.0 at that site
FW - fillet without skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public (adult) of 7.5 g/day, or 1 8-oz meal per month, and for general public (child) of 2.83 g/day, or 0.4 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month, and for general public (child) of 77.95 g/day, or 11 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month, and for child fish consumers of 24.8 g/day, or 3 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month, and for child fish consumers of 162 g/day, or 22 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 6 - located in the Columbia River between the Bonneville Dam and the Dalles Dam; 7 - located in the Columbia River between the Dalles Dam and the John Day Dam; 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9L - located in the upper Columbia River below the Snake River; 9U, located in the upper Columbia River above the Snake River; 13 - Snake River.

Up to eight health endpoints exceeded a value of 1.0 for white sturgeon depending on the target population and exposure parameters used for calculations. The eight endpoints were immune system, liver, central nervous system, reproduction/development, selenosis, cardiovascular, hyperpigmentation/keratosis, and gastrointestinal in decreasing order of toxicity based on basin average total hazard indices of whole body samples. Among specific sampling sites, total hazard indices were generally lowest at Site 7 and Site 8 for fillet without skin samples and Site 9L for whole body samples. Total hazard indices were highest at Site 9U for fillet without skin samples and at Site 8 for whole body samples. Total indices among sites varied by a factor of 5.2 for fillet with skin samples and by 1.5 for whole body samples.

Chemicals With Hazard Quotients At or Above 1.0

Individual chemicals with a hazard quotient at or above 1.0 collected from six sites in fillet without skin samples of white sturgeon and from three sites in whole body samples were identified and shown in Table 4.2. Hazard quotients for other individual chemicals are presented in Appendix G. A total of four individual chemicals were identified with hazard quotients at or above 1.0 in fillet without skin samples of white sturgeon: total Aroclors, mercury, total DDT, and selenium, in decreasing order of toxicity based on the Native American child, high fish consumption rate. A total of six individual chemicals were identified with hazard quotients at or above 1.0 in whole body samples of white

sturgeon: total Aroclors, total DDT, mercury, arsenic, chromium, and selenium, in decreasing order of toxicity based on the Native American child, high fish consumption rate. Total Aroclors were comprised of Aroclor 1254 and Aroclor 1260, depending on the sampling site.

Table 4.2 . Chemicals having hazard quotients at or above 1.0 in white sturgeon

ADULTS				CHILDREN			
TISSUE TYPE/CHEMICAL	HAZARD QUOTIENT AFC	HAZARD QUOTIENT HFC	SITES[a] WITH VALUES >1 (total # of sites)	TISSUE TYPE/CHEMICAL	HAZARD QUOTIENT AFC	HAZARD QUOTIENT HFC	SITES[a] WITH VALUES >1 (total # of sites)
General Public							
Fillet without skin							
Total Aroclors	2.1	5.9-40	6[b],7[b],8[b],9L[b],**9U**,13[b] (6)	Total Aroclors	1.8	7.6-51	6[b],7[b],8[b],9L[b],**9U**,13[b] (6)
Total DDT	–	1.5-7.1	6,7,8,9L,**9U**,13 (6)	Total DDT	–	1.9-9.1	6,7,8,9L,**9U**,13 (6)
Mercury	–	1.0-7.3	6,7,8,9L,**9U**,13 (6)	Mercury	–	1.3-9.4	6,7,8,9L,**9U**,13 (6)
Whole body							
Total Aroclors	1.1	13-20	**8**,9L[b],9U[b] (3)	Total Aroclors	–	17-26	**8**,9L,9U (3)

Total DDT	–	2.6-3.7	**8**,9L,9U (3)	Total DDT	–	3.4-4.7	**8**,9L,9U (3)
Mercury	–	1.9-3.5	**8**,9L,9U (3)	Mercury	–	2.4-4.4	**8**,9L,9U (3)
Native American							
Fillet skin							
Total Aroclors	2.6-18	16-110	6[b],7[b],8[b],9L,**9U**,13[b] (6)	Total Aroclors	4.8-32	32-210	6,7,8,9L,**9U**,13 (6)
Total DDT	1.3-3.2	4.1-20	6,7,8,9L,**9U** (6)	Total DDT	1.2-5.8	8.0-38	6,7,8,9L,**9U**,13 (6)
Mercury	1.0-3.3	2.8-20	6,7,8[b],9L[b],**9U**,13 (6)	Arsenic	–	1.1-1.2	6,**7,8,9L** (6)
Selenium	–	1.3-2.0	7,8,**9L** (6)	Mercury	1.8-6.0	5.5-39	6,7,8[b],9L,**9U**,13 (6)
				Selenium	–	1.4-3.8	7,8,**9L**,9U,13 (6)
Whole body							
Total Aroclors	5.7-9.0	35-56	**8**,9L,9U (3)	Total Aroclors	11-17	69-110	**8**,9L,9U (3)
Total DDT	1.2-1.6	7.8-10	**8**,9L,9U (3)	Total DDT	2.1-3.0	14-20	**8**,9L,9U (3)
Mercury	1.2-1.5	5.1-9.5	**8**,9L,9U[b] (3)	Arsenic	–	1.0-1.8	**8**,9L,9U (3)
				Chromium	–	1.1-1.8	8,**9L** (3)
				Mercury	1.5-2.8	9.9-19	**8**,9L,9U (3)
				Selenium	–	1.1-1.7	8,**9L**,9U (3)

NOTE: AFC - average fish consumption
HFC - high fish consumption
– - value less than 1.0
Bold indicates site with highest HQ

[a] Site - Waterbody: 6 - located in the Columbia River between the Bonneville Dam and the Dalles Dam; 7 - located in the Columbia River between the Dalles Dam and the John Day Dam; 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9L - located in the upper Columbia River below the Snake River; 9U, located in the upper Columbia River above the Snake River; 13 - Snake River.

[b] HFC only

Cancer Risks Estimates

Cancer risks were estimated for general public and Columbia River Basin Native American adults at both 30- and 70-year exposure durations. Cancer risk estimates for

detected carcinogenic chemicals at each sampling site are presented in Appendix I. Total cancer risk estimates are presented in Table 4.3 for each sampling site and for the basin average. Sampling sites were not replicated within a tributary and, therefore, tributary risk estimates were not calculated.

Table 4.3 Total cancer risk for white sturgeon

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk						
		Site[e]						Basin Average
		6	7	8	9L	9U	13	
General Public[a,b]								
AFC/30-yr	FW	$4x10^{-5}$	$3x10^{-5}$	$4x10^{-5}$	$8x10^{-5}$	$1x10^{-4}$	$3x10^{-5}$	$5x10^{-5}$
	WB	na	na	$7x10^{-5}$	$6x10^{-5}$	$7x10^{-5}$	na	$7x10^{-5}$
HFC/30-yr	FW	$8x10^{-4}$	$6x10^{-4}$	$7x10^{-4}$	$1x10^{-3}$	$2x10^{-3}$	$6x10^{-4}$	$9x10^{-4}$
	WB	na	na	$1x10^{-3}$	$1x10^{-3}$	$1x10^{-3}$	na	$1x10^{-3}$
AFC/70-yr	FW	$9x10^{-5}$	$7x10^{-5}$	$8x10^{-5}$	$2x10^{-4}$	$3x10^{-4}$	$7x10^{-5}$	$1x10^{-4}$
	WB	na	na	$2x10^{-4}$	$1x10^{-4}$	$2x10^{-4}$	na	$2x10^{-4}$
HFC/70-yr	FW	$2x10^{-3}$	$1x10^{-3}$	$2x10^{-3}$	$3x10^{-3}$	$5x10^{-3}$	$1x10^{-3}$	$2x10^{-3}$
	WB	na	na	$3x10^{-3}$	$3x10^{-3}$	$3x10^{-3}$	na	$3x10^{-3}$
Native American[c,d]								
AFC/30-yr	FW	$3x10^{-4}$	$3x10^{-4}$	$3x10^{-4}$	$6x10^{-4}$	$1x10^{-3}$	$3x10^{-4}$	$4x10^{-4}$
	WB	na	na	$6x10^{-4}$	$5x10^{-4}$	$6x10^{-4}$	na	$6x10^{-4}$
HFC/30-yr	FW	$2x10^{-3}$	$2x10^{-3}$	$2x10^{-3}$	$4x10^{-3}$	$6x10^{-3}$	$2x10^{-3}$	$3x10^{-3}$
	WB	na	na	$4x10^{-3}$	$3x10^{-3}$	$4x10^{-3}$	na	$3x10^{-3}$
AFC/70-yr	FW	$8x10^{-4}$	$6x10^{-4}$	$7x10^{-4}$	$1x10^{-3}$	$2x10^{-3}$	$6x10^{-4}$	$1x10^{-3}$
	WB	na	na	$1x10^{-3}$	$1x10^{-3}$	$1x10^{-3}$	na	$1x10^{-3}$
HFC/70-yr	FW	$5x10^{-3}$	$4x10^{-3}$	$4x10^{-3}$	$9x10^{-3}$	$1x10^{-2}$	$4x10^{-3}$	$6x10^{-3}$
	WB	na	na	$9x10^{-3}$	$7x10^{-3}$	$8x10^{-3}$	na	$8x10^{-3}$

NOTE: AFC - average fish consumption
HFC - high fish consumption
na - not applicable; sample type not analyzed at this site
FW - fillet without skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 7.5 g/day, or 1 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 6 - located in the Columbia River between the Bonneville Dam and the Dalles Dam; 7 - located in the Columbia River between the Dalles Dam and the John Day Dam; 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9U, located in the upper Columbia River above the Snake River; 9L - located in the upper Columbia River below the Snake River; 13 - Snake River.

Carcinogenic Chemicals with Estimated Risks At or Above 10^{-5}

Cancer risk estimates vary across populations, consumption rates, and exposure levels by constant factors. Chemicals in white sturgeon with cancer risks at or above 1×10^{-5} are shown for the Columbia River Basin Native American population with average fish consumption rates at a 70-year exposure duration; total cancer risk for all chemicals are also shown (Tables 4.4.1 and 4.4.2). Multiplicative factors used to estimate risk at different exposure parameters and target populations are footnoted in the table. In addition, Appendix I shows individual risk estimates for each detected chemical for all the exposure scenarios used in this risk assessment

The same three chemicals were identified as having the highest cancer risk for all sites and tissue types for white sturgeon: 2,3,7,8-TCDF, adjusted Aroclors, and DDE. The highest risk estimate of the three chemicals varied among sites, although 2,3,7,8-TCDF was the highest for most of the fillet without skin samples. Aroclors 1254 and 1260 were the only individual Aroclors detected and used in the adjusted Aroclor calculation for all sites and tissue types.

Table 4.4.1 Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American population at average fish consumption and 70-year exposure duration in white sturgeon, whole body

		White Sturgeon - Whole body		
		Site		
	Chemical	8	9L	9U
PCBs	Adjusted Aroclors	3E-04	2E-04	3E-04
	PCB 105	6E-05	4E-05	5E-05
	PCB 114	2E-05	2E-05	2E-05
	PCB 118	7E-05	5E-05	5E-05
	PCB 156	1E-04	9E-05	9E-05
	PCB 157	2E-05	2E-05	2E-05
Dioxin/furans	2,3,4,7,8-PeCDF	2E-05	3E-05	2E-05
	2,3,7,8-TCDD	9E-05	1E-04	9E-05
	2,3,7,8-TCDF	3E-04	3E-04	4E-04
Pesticides	Aldrin		2E-05	2E-05
	Chlordane (total)		1E-05	
	DDD	2E-05	3E-05	5E-05
	DDE	2E-04	2E-04	2E-04
	Hexachlorobenzene		2E-05	1E-05
Inorganic	Arsenic	7E-05	4E-05	4E-05
	Total Cancer Risk for All Chemicals	1E-03	1E-03	1E-03

Table 4.4.2 Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American population at average fish consumption and 70-year exposure duration in white sturgeon, fillet without skin

		White Sturgeon - Fillet without skin					
		Site					
	Chemical	6	7	8	13	9L	9U
PCBs	Adjusted Aroclors	2E-04	1E-04	1E-04	1E-04	3E-04	7E-04
	PCB 105	3E-05	2E-05	2E-05	3E-05	4E-05	1E-04
	PCB 114	1E-05			1E-05	2E-05	5E-05
	PCB 118	3E-05	2E-05	2E-05	4E-05	5E-05	2E-04
	PCB 126		2E-05				
	PCB 156	4E-05	3E-05	3E-05	5E-05	9E-05	2E-04
	PCB 157					2E-05	5E-05
Dioxin/furans	1,2,3,7,8-PeCDD	1E-05	2E-05	2E-05	1E-05		
	2,3,4,7,8-PeCDF		1E-05	2E-05		2E-05	2E-05
	2,3,7,8-TCDD	4E-05	5E-05	6E-05	5E-05	1E-04	3E-05
	2,3,7,8-TCDF	2E-04	2E-04	2E-04	6E-05	5E-04	3E-04
Pesticides	Aldrin					2E-05	1E-05
	Chlordane (total)					1E-05	2E-05

	DDD	**1E-05**	**1E-05**	**1E-05**	**1E-05**	**4E-05**	**8E-05**
	DDE	**1E-04**	**1E-04**	**1E-04**	**1E-04**	**2E-04**	**4E-04**
	Hexachlorobenzene					**2E-05**	
Inorganic	**Arsenic**	**4E-05**	**5E-05**	**5E-05**	**3E-05**	**5E-05**	**4E-05**
	Total Cancer Risk for All Chemicals	**8E-04**	**6E-04**	**7E-04**	**6E-04**	**1E-03**	**2E-03**

NOTE: A blank indicates that this chemical does not have a cancer risk greater than $1x10^{-5}$ for this tissue type at this site.

To estimate risk levels for general public AFC 30-year exposure, divide the cells in this table by 19.64.

To estimate risk levels for general public HFC 30-year exposure, divide the cells in this table by 1.03.

To estimate risk levels for Native American AFC 30-year exposure, divide the cells in this table by 2.34.

To estimate risk levels for Native American HFC 30-year exposure, divide the cells in this table by 0.38.

To estimate risk levels for general public AFC 70-year exposure, divide the cells in this table by 8.43.

To estimate risk levels for general public HFC 70-year exposure, divide the cells in this table by 0.44.

To estimate risk levels for Native American AFC 70-year exposure, divide the cells in this table by 0.16.

[a] Site - Waterbody: 6 - located in the Columbia River between the Bonneville Dam and the Dalles Dam; 7 -located in the Columbia River between the Dalles Dam and the John Day Dam; 8 - located in the Columbia River between the John Day Dam and the McNary Dam; 9U, located in the upper Columbia River above the Snake River; 9L - located in the upper Columbia River below the Snake River; 13 - Snake River.

Appendix O-5 Walleye

Walleye were collected from two sites in the Columbia River Basin: 7, Columbia River and 30, Umatilla River. Chemical analyses were performed on two tissue types, fillet with skin and whole body, except for fish collected from Site 7 where only whole body samples were analyzed. The risk estimates characterized in this section are based on average chemical concentrations determined from two replicate composite samples collected from Site 7 and three replicate composite samples collected from Site 30 for fillet with skin samples and one composite sample for whole body samples at Site 30 (Appendix A). Data are presented at two spatial scales: site and basin. Walleye were not collected from replicate sampling sites within a tributary and, therefore, tributary risk estimates were not calculated.

Noncarcinogenic Health Effects

The potential noncarcinogenic health effects associated with the consumption of fillet with skin and whole body walleye were assessed by calculating hazard quotients for all detected chemicals with oral reference doses (Appendix G). The hazard quotients of chemicals with the same health endpoint were summed to calculate endpoint-specific hazard indices. In addition, the hazard quotients of all detected chemicals were summed to calculate a total hazard index for the site or basin. Table 5.1 shows the total hazard

index for each of the target populations evaluated in this risk assessment and the health endpoints which were at or above a hazard index of 1.0.

Table 5.1 Total hazard indices and noncarcinogenic health endpoints with hazard indices exceeding 1.0 for walleye

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index: Site[e] 7	Hazard Index: Site[e] 30	Hazard Index: Basin Average[f]
General Public - Adult[a,b]					
AFC	FS	**Total HI**	na	0.3	0.3
AFC	WB	**Total HI**	1.1	0.4	1.0
HFC	FS	Liver	na	1.3	1.3
		Central nervous system	na	3.6	3.6
		Immune system	na	1.3	1.3
		Reproduction and development	na	3.6	3.6
		Total HI	na	6.6	6.6
HFC	WB	Liver	2.4	–	2.3
		Central nervous system	4.2	3.6	3.6
		Immune system	13	2.3	13
		Reproduction and development	4.2	3.6	3.6
		Total HI	21	6.7	20
General Public - Child[a,b]					
AFC	FS	**Total HI**	na	0.3	0.3
AFC	WB	**Total HI**	1.0	0.3	0.9
HFC	FS	Liver	na	1.6	1.6
		Central nervous system	na	4.6	4.6
		Immune system	na	1.6	1.6
		Reproduction and development	na	4.6	4.6
		Total HI	na	8.4	8.4
HFC	WB	Liver	3.1	–	2.9
		Central nervous system	5.4	4.6	4.6
		Immune system	17	2.9	16
		Reproduction and development	5.4	4.6	4.6
		Total HI	27	8.6	25
Native American - Adult[c,d]					
AFC	FS	Central nervous system	na	1.6	1.6
		Reproduction and development	na	1.6	1.6
		Total HI	na	2.9	2.9
AFC	WB	Liver	1.1	–	1.0
		Central nervous system	1.9	1.6	1.6

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index		
			Site[e]		Basin Average[f]
			7	30	
		Immune system	5.9	1.0	5.7
		Reproduction and development	1.9	1.6	1.6
		Total HI	9.2	3.0	8.7
HFC	FS	Liver	na	3.5	3.5
		Central nervous system	na	9.8	9.8
		Immune system	na	3.5	3.5
		Reproduction and development	na	9.7	9.7
		Total HI	na	18	18
HFC	WB	Liver	6.7	1.1	6.2
		Central nervous system	12	9.8	9.9
		Immune system	36	6.3	35
		Reproduction and development	12	9.7	9.9
		Total HI	57	18	53
Native American - Child[c,d]					
AFC	FS	Liver	na	1.0	1.0
		Central nervous system	na	2.9	2.9
		Immune system	na	1.0	1.0
		Reproduction and development	na	2.9	2.9
		Total HI	na	5.3	5.3
AFC	WB	Liver	2.0	–	1.9
		Central nervous system	3.4	2.9	3.0
		Immune system	11	1.9	10
		Reproduction and development	3.4	2.9	2.9
		Total HI	17	5.5	16
HFC	FS	Liver	na	6.8	6.8
		Cardiovascular	na	1.3	1.3
		Central nervous system	na	19	19
		Immune system	na	6.8	6.8
		Reproduction and development	na	19	19
		Hyperpigmentation/keratosis	na	1.3	1.3
		Total HI	na	35	35
HFC	WB	Liver	13	2.2	12
		Cardiovascular	1.8	1.3	1.8
		Central nervous system	22	19	19
		Immune system	71	12	68
		Reproduction and development	22	19	19
		Hyperpigmentation/keratosis	1.8	1.3	1.8
		Selenosis	1.1	–	1.0
		Total HI	110	36	104

NOTE: AFC - average fish consumption
HFC - high fish consumption
HI - hazard index
na - not applicable; sample type not analyzed at this site
– - health endpoint <1.0 at that site
FS - fillet with skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public (adult) of 7.5 g/day, or 1 8-oz meal per month, and for general public (child) of 2.83 g/day, or 0.4 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month, and for general public (child) of 77.95 g/day, or 11 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month, and for child fish consumers of 24.8 g/day, or 3 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month, and for child fish consumers of 162 g/day, or 22 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 7 - located in the Columbia River between the Dalles Dam and the John Day Dam; 30 - Umatilla River

[f] Basin average hazard indices equals Site 30 for FS samples.

Up to seven health endpoints exceeded a value of 1.0 for walleye depending on the target population and exposure parameters used for calculations. The seven endpoints were immune system, central nervous system, reproduction/development, liver, cardiovascular, hyperpigmentation/keratosis, and selenosis in decreasing order of toxicity based on basin average hazard indices. For whole body samples, which were collected at both Site 7 and Site 30, total hazard indices varied by a factor of 3.1 between sites.

Chemicals With Hazard Quotients At or Above 1.0

Individual chemicals with a hazard quotient at or above 1.0 in fillet with skin samples of walleye collected from Site 7 and Site 30 and in whole body samples collected from Site 30 were identified and are shown in Table 5.2. Hazard quotients for other individual chemicals are presented in Appendix G. A total of five individual chemicals were identified as having hazard quotients at or above 1.0 in fillet with skin samples of walleye: mercury, total Aroclors, thallium, arsenic, and total DDT, in decreasing order of toxicity based on the Native American child, high fish consumption rate. A total of five individual chemicals were identified as having hazard quotients at or above 1.0 in whole body

samples of walleye: total Aroclors, mercury, total DDT, arsenic, and selenium, in decreasing order of toxicity based on the Native American child, high fish consumption rate. Total Aroclors were comprised of Aroclor 1254 in fillet with skin samples and Aroclor 1254 and Aroclor 1260 in whole body samples.

Table 5.2 Chemicals having hazard quotients at or above 1.0 in walleye

	ADULTS				CHILDREN		
	HAZARD QUOTIENT		SITES[a] WITH VALUES >1		HAZARD QUOTIENT		SITES[a] WITH VALUES >1
TISSUE TYPE/CHEMICAL	AFC	HFC	(total # of sites)	TISSUE TYPE/ CHEMICAL	AFC	HFC	(total # of sites)
General Public							
Fillet with skin							
Total Aroclors	–	1.3	30 (1)	Total Aroclors	–	1.7	30 (1)
Mercury	–	3.6	30 (1)	Mercury	–	4.6	30 (1)
				Thallium	–	1.1	30 (1)
Whole body							
Total Aroclors	–	2.3-13	**7**,30 (2)	Total Aroclors	–	2.9-17	**7**,30 (2)
Total DDT	–	2.1	7 (2)	Total DDT	–	2.7	7 (2)
Mercury	–	3.6-4.2	**7**,30 (2)	Mercury	–	4.6-5.4	**7**,30 (2)
Native American							
Fillet with skin							
Total Aroclors	–	3.5	30 (1)	Total Aroclors	1.1	6.8	30 (1)
Mercury	1.6	9.7	30 (1)	Total DDT	–	1.2	30 (1)
				Arsenic	–	1.3	30 (1)
				Mercury	2.9	19	30 (1)
				Thallium	–	4.7	30 (1)
Whole body							
Total Aroclors	1.0-5.9	6.3-36	**7**,30 (2)	Total Aroclors	1.9-11	12-71	**7**,30 (2)
Total DDT	–	5.8	7 (2)	Total DDT	1.7	1.3-11	**7**,30[b] (2)
Mercury	1.6-1.9	9.7-12	**7**,30 (2)	Arsenic	–	1.3-1.8	**7**,30 (2)
				Mercury	2.9-3.4	19-22	**7**,30 (2)
				Selenium	–	1.1	7 (2)

NOTE: AFC - average fish consumption
HFC - high fish consumption
– - value less than 1.0
Bold indicates site with highest HQ

[a] Site - Waterbody: 7 - located in the Columbia River between the Dalles Dam and the John Day Dam; 30 - Umatilla River

Cancer Risk Estimates

Cancer risks were estimated for general public and Columbia River Basin Native American adults at both 30- and 70-year exposure durations. Cancer risk estimates for detected carcinogenic chemicals at each sampling site are presented in Appendix I. Total cancer risk estimates are presented in Table 5.3 for each sampling site and for the basin average. Sampling sites were not replicated within a tributary and, therefore, tributary risk estimates were not calculated.

Table 5.3 Total cancer risk for walleye

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk		
		Site[e]		Basin Average
		7	30	
General Public[a,b]				
AFC/30-yr	FS	na	$8x10^{-6}$	$8x10^{-6}$
	WB	$6x10^{-5}$	$9x10^{-6}$	$5x10^{-5}$
HFC/30-yr	FS	na	$1x10^{-4}$	$1x10^{-4}$
	WB	$1x10^{-3}$	$2x10^{-4}$	$1x10^{-3}$
AFC/70-yr	FS	na	$2x10^{-5}$	$2x10^{-5}$
	WB	$1x10^{-4}$	$2x10^{-5}$	$1x10^{-4}$
HFC/70-yr	FS	na	$3x10^{-4}$	$3x10^{-4}$
	WB	$3x10^{-3}$	$4x10^{-4}$	$2x10^{-3}$
Native American[c,d]				
AFC/30-yr	FS	na	$6x10^{-5}$	$6x10^{-5}$
	WB	$5x10^{-4}$	$7x10^{-5}$	$4x10^{-4}$
HFC/30-yr	FS	na	$4x10^{-4}$	$4x10^{-4}$
	WB	$3x10^{-3}$	$4x10^{-4}$	$3x10^{-3}$
AFC/70-yr	FS	na	$2x10^{-4}$	$2x10^{-4}$
	WB	$1x10^{-3}$	$2x10^{-4}$	$1x10^{-3}$
HFC/70-yr	FS	na	$9x10^{-4}$	$9x10^{-4}$
	WB	$7x10^{-3}$	$1x10^{-3}$	$6x10^{-3}$

NOTE: AFC - average fish consumption
HFC - high fish consumption
na - not applicable; sample type not analyzed at this site
FS - fillet with skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 7.5 g/day, or 1 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 7 - located in the Columbia River between the Dalles Dam and the John Day Dam; 30 - Umatilla River.

Carcinogenic Chemicals with Estimated Risks At or Above 10^{-5}

Cancer risk estimates vary across populations, consumption rates, and exposure levels by constant factors. Chemicals in walleye with cancer risks at or above 1 x 10^{-5} are shown for the Columbia River Basin Native American population with average fish consumption rates at a 70-year exposure duration; total cancer risk for all chemicals are also shown (Tables 5.4.1 and 5.4.2). Multiplicative factors used to estimate risk at different exposure parameters and target populations are footnoted in the table. In addition, Appendix I shows individual risk estimates for each detected chemical for all the exposure scenarios used in this risk assessment

Five chemicals have risks at or above 1 x 10^{-5} in whole body samples at site 7: adjusted Aroclors, PCBs 118, 126 and 156, and DDE. Adjusted Aroclors had the highest risk estimate for whole body samples at Site 7. Whole body and fillet with skin samples at site 30 had no risks above 1 x 10^{-5}. Aroclors 1254 and 1260 were the only individual Aroclors detected and used in the adjusted Aroclor calculation for all sites and tissue types. Aroclor 1260 was not detected in fillet with skin samples at Site 30. Arsenic had the highest risk estimate for both tissue types at Site 30.

Table 5.4.1 Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American population at average fish consumption and 70-year exposure duration in walleye, whole body

		Walleye-Whole Body	
		Site	
	Chemical	7	30
Aroclors	**Adjusted Aroclors**	**2E-04**	**4E-05**
	PCB 105	**6E-05**	
	PCB 114	**3E-05**	
	PCB 118	**1E-04**	
	PCB 126	**2E-04**	
	PCB 156	**1E-04**	
	PCB 157	**2E-05**	
Dioxin/furans	**1,2,3,7,8-PeCDD**	**3E-05**	**1E-05**
	2,3,4,7,8-PeCDF	**2E-05**	
	2,3,7,8-TCDD	**5E-05**	**1E-05**
	2,3,7,8-TCDF	**7E-05**	
Pesticides	**DDD**	**1E-05**	
	DDE	**1E-04**	**1E-05**
Inorganic	**Arsenic**	**7E-05**	**5E-05**

Table 5.4.2 Chemicals with cancer risks at or above 1 x 10^{-5} for Columbia River Basin Native American population at average fish consumption and 70-year exposure duration in walleye, fillet with skin

		Walleye-Fillet with skin
		Site
	Chemical	30
PCBs	Adjusted Arochlors	2E-05
Dioxin/furans	1,2,3,7,8-PeCDD	1E-05
	2,3,7,8-TCDD	1E-05
Pesticides	DDE	1E-05
Inorganic	Arsenic	5E-05
	Total Cancer Risk for All Chemicals	**2E-04**

NOTE: na - not applicable; indicates that this tissue type was not measured at this site.

A blank indicates that this chemical does not have an estimated cancer risk at or above 10^{-5} for this site and tissue type.

To estimate risk levels for general public AFC 30-year exposure, divide the cells in this table by 19.64.

To estimate risk levels for general public HFC 30-year exposure, divide the cells in this table by 1.03.

To estimate risk levels for Native American AFC 30-year exposure, divide the cells in this table by 2.34.

To estimate risk levels for Native American HFC 30-year exposure, divide the cells in this table by 0.38.

To estimate risk levels for general public AFC 70-year exposure, divide the cells in this table by 8.43.

To estimate risk levels for general public HFC 70-year exposure, divide the cells in this table by 0.44.

To estimate risk levels for Native American AFC 70-year exposure, divide the cells in this table by 0.16.

[a] Site - Waterbody: 7 - located in the Columbia River between the Dalles Dam and the John Day Dam;
30 - Umatilla River.

Appendix O-6 Rainbow Trout

Rainbow trout were collected from four sites in the Columbia River Basin: 56, Klickitat River; 98, Deschutes River; 101, Umatilla River; and 49, Yakima River. Chemical analyses were performed on two tissue types, fillet with skin and whole body, except at Site 56 and Site 101 where only whole body samples were analyzed. The risk estimates characterized in this section are based on average chemical concentrations determined from 2–4 replicate composite samples. Two replicate composites were analyzed for whole body samples at Site 56, three replicate composites for fillet with skin and whole body samples at Site 49 and for whole body samples at Site 98, and four replicate composites for fillet with skin samples at Site 98 and Site 101 (Appendix A). Data are presented at two spatial scales: site and basin. Rainbow trout were not collected from replicate sampling sites within a tributary and, therefore, tributary risk estimates were not calculated.

Noncarcinogenic Health Effects

The potential noncarcinogenic health effects associated with the consumption of fillet with skin and whole body rainbow trout were assessed by calculating hazard quotients for all detected chemicals with oral reference doses (Appendix G). The hazard quotients of chemicals with the same health endpoint were summed to calculate endpoint-specific hazard indices. In addition, the hazard quotients of all detected chemicals were summed to calculate a total hazard index for the site or basin. Table 6.1 shows the total hazard index for each of the target populations evaluated in this risk assessment and the health endpoints which were at or above a hazard index of 1.0.

Table 6.1. Total hazard indices and noncarcinogenic health endpoints with hazard indices at or above 1.0 for rainbow trout

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index: Site[e] 56	98	101	49	Basin Average
General Public - Adult[a,b]							
AFC	FS	**Total HI**	na	0.2	na	0.2	0.2
AFC	WB	**Total HI**	0.2	0.3	0.1	0.2	0.3
HFC	FS	Central nervous system	na	1.7	na	1.4	1.6
		Immune system	na	1.6	na	1.2	1.4

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index				
			Site[e]				Basin
			56	98	101	49	Average
		Reproduction/ development	na	1.7	na	1.4	1.6
		Total HI	na	3.6	na	3.0	3.4
HFC	WB	Central nervous system	1.6	2.9	–	–	1.5
		Immune system	1.2	1.9	–	1.5	2.3
		Reproduction/ development	1.6	2.9	–	–	1.5
		Total HI	3.9	5.5	2.8	3.3	4.8
General Public - Child[a,b]							
AFC	FS	**Total HI**	na	0.2	na	0.1	0.2
AFC	WB	**Total HI**	0.2	0.3	0.1	0.2	0.2
HFC	FS	Central nervous system	na	2.1	na	1.8	2.0
		Immune system	na	2.0	na	1.5	1.8
		Reproduction/ development	na	2.1	na	1.8	2.0
		Total HI	na	4.6	na	3.8	4.3
HFC	WB	Central nervous system	2.1	3.7	1.0	1.3	1.9
		Immune system	1.6	2.4	1.2	1.9	3.0
		Reproduction/ development	2.1	3.7	–	1.2	1.9
		Total HI	5.0	7.0	3.6	4.3	6.1
Native American - Adult[c,d]							
AFC	FS	**Total HI**	na	1.6	na	1.3	1.5
AFC	WB	Central nervous system	–	1.3	–	–	0.7
		Reproduction/ development	–	1.3	–	–	0.7
		Total HI	1.7	2.4	1.3	1.5	2.1
HFC	FS	Central nervous system	na	4.6	na	3.9	4.3
		Immune system	na	4.3	na	3.2	3.8
		Reproduction/ development	na	4.6	na	3.9	4.3
		Total HI	na	9.8	na	8.2	9.2
HFC	WB	Liver	–	–	–	1.4	0.8
		Central nervous system	4.5	8.0	2.2	2.7	4.2
		Immune system	3.3	5.2	2.5	4.0	6.4
		Reproduction/ development	4.4	7.9	2.0	2.6	4.0
		Total HI	11	15	7.7	9.1	13
Native American - Child[c,d]							
AFC	FS	Central nervous system	na	1.4	na	1.2	1.3
		Immune system	na	1.3	na		1.1
		Reproduction/	na	1.4	na	1.1	1.3

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index Site[e] 56	98	101	49	Basin Average
		development					
		Total HI	na	2.9	na	2.4	2.7
AFC	WB	Central nervous system	1.3	2.4	–	–	1.2
		Immune system	–	1.5	–	1.2	1.9
		Reproduction/ development	1.3	2.4	–	–	1.2
		Total HI	3.2	4.4	2.3	2.7	3.9
HFC	FS	Liver	na	–	na	1.6	1.0
		Central nervous system	na	8.9	na	7.5	8.3
		Immune system	na	8.4	na	6.3	7.5
		Reproduction/ development	na	8.9	na	7.5	8.3
		Total HI	na	19	na	16	18
HFC	WB	Liver	1.5	1.1	1.0	2.6	1.5
		Cardiovascular	1.8	–	–	–	0.4
		Central nervous system	8.7	16	4.3	5.3	8.1
		Immune system	6.5	10	4.8	7.7	12
		Metabolism	1.1	1.3	1.3	1.0	1.2
		Reproduction/ development	8.5	15	4.0	5.0	7.8
		Hyperpigmentation/keratosis	1.8	–	–	–	0.4
		Selenosis	1.3	–	–	–	0.8
		Total HI	21	29	15	18	26

NOTE: AFC - average fish consumption
HFC - high fish consumption
HI - hazard index
na - not applicable; sample type not analyzed at this site
– - health endpoint <1.0 at that site
FS - fillet with skin
WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public (adult) of 7.5 g/day, or 1 8-oz meal per month, and for general public (child) of 2.83 g/day, or 0.4 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month, and for general public (child) of 77.95 g/day, or 11 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month, and for child fish consumers of 24.8 g/day, or 3 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month, and for child fish consumers of 162 g/day, or 22 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 49 - Yakima River; 56 - Klickitat River; 98 - Deschutes River; 101 - Umatilla River.

Up to eight health endpoints exceeded a value of 1.0 for rainbow trout depending on the target population and exposure parameters used for calculations. The eight endpoints were immune system, central nervous system, reproduction/development, liver, metabolism, selenosis, cardiovascular, and hyperpigmentation/keratosis in decreasing order of toxicity based on basin average hazard indices in whole body samples. Hazard indices were consistently highest at Site 98 in the Deschutes River, and generally lowest at Site 101 in the Umatilla River. Total hazard indices varied among sites by a factor of 1.2 in fillet with skin samples and by 1.9 in whole body samples.

Chemicals with Hazard Quotients At or Above 1.0

Individual chemicals with a hazard quotient at or above 1.0 in fillet with skin samples of rainbow trout collected from Site 49 and Site 98 and in whole body samples collected from Sites 49, 56, 98, and 101 were identified and are shown in Table 6.2. Hazard quotients for other individual chemicals are presented in Appendix G. A total of three individual chemicals were identified as having hazard quotient at or above 1.0 in fillet with skin samples of rainbow trout: mercury, total Aroclors and total DDT, in decreasing order of toxicity based on the Native American child, high fish consumption rate. A total of five individual chemicals were identified with hazard quotients at or above 1.0 in whole body samples: mercury, total Aroclors, total DDT, arsenic, and zinc, in decreasing order of toxicity based on the Native American child, high fish consumption rate. Total Aroclors were comprised of Aroclor 1254 in fillet with skin samples and Aroclor 1254 and Aroclor 1260 in whole body samples, depending on the sampling site.

Table 6.2 Chemicals having hazard quotients at or above 1.0 in rainbow trout

ADULTS				CHILDREN			
	HAZARD QUOTIENT		SITES[a] WITH VALUES >1 (total # of sites)		HAZARD QUOTIENT		SITES[a] WITH VALUES >1 (total # of sites)
TISSUE TYPE/ CHEMICAL	AFC	HFC		TISSUE TYPE/ CHEMICAL	AFC	HFC	
General Public							
Fillet with skin							
Total Aroclors	–	1.2-1.6	**98**,49 (2)	Total Aroclors	–	1.5-2.0	**98**,49 (2)
Mercury	–	1.4-1.7	**98**,49 (2)	Mercury	–	1.8-2.1	**98**,49 (2)
Whole body							

Adults				Children			
	Hazard Quotient		Sites[a] with Values >1 (total # of sites)		Hazard Quotient		Sites[a] with Values >1 (total # of sites)
Tissue Type/ Chemical	AFC	HFC		Tissue Type/ Chemical	AFC	HFC	
Total Aroclors	–	1.2-1.9	56,**98**,49 (4)	Total Aroclors	–	1.2-2.4	56,**98**,49 (4)
Mercury	–	1.6-2.9	56,**98** (4)	Mercury	–	2.1-3.7	56,**98** (4)
Native American							
Fillet with skin							
Total Aroclors	–	4.3-3.2	**98**,49 (2)	Total Aroclors	1.3	6.3-8.4	**98**,49[b] (2)
Mercury	–	3.9-4.6	**98**,49 (2)	Total DDT	–	1.1	49 (2)
				Mercury	1.2-1.4	7.5-8.9	**98**,49 (2)
Whole body							
Total Aroclors	–	2.5-5.2	56,**98**,101,49 (4)	Total Aroclors	1.2-1.5	4.8-10	56[b],**98**,101[b], 49 (4)
Total DDT	–	1	49 (4)	Total DDT	–	2	49 (4)
Mercury	1.3	2.0-7.9	56[b],**98**,101[b],49[b] (4)	Arsenic	–	1.8	56 (4)
				Mercury	1.3-2.4	4.0-15	56,**98**,101[b],49[b] (4)
				Zinc	–	1.3	98 (4)

NOTE: AFC - average fish consumption
HFC - high fish consumption
– - value less than 1.0
Bold indicates site with highest HQ

[a] Site - Waterbody: 49 - Yakima River; 56 - Klickitat River; 98 - Deschutes River; 101 - Umatilla River.

[b] HFC only

Cancer Risk Estimates

Cancer risks were estimated for general public and Columbia River Basin Native American adults at both 30- and 70-year exposure durations. Cancer risk estimates for detected carcinogenic chemicals at each sampling site are presented in Appendix I. Total cancer risk estimates are presented in Table 6.3 for each sampling site and for the basin average. Sampling sites were not replicated within a tributary and, therefore, tributary risk estimates were not calculated.

Table 6.3. Total cancer risks for rainbow trout

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk	
		Site[e]	Basin Average

		56	98	49	101	
General Public[a,b]						
AFC/30-yr	FS	na	$8x10^{-6}$	$8x10^{-6}$	na	$8x10^{-6}$
	WB	$7x10^{-6}$	$1x10^{-5}$	$1x10^{-5}$	$6x10^{-6}$	$1x10^{-5}$
HFC/30-yr	FS	na	$2x10^{-4}$	$2x10^{-4}$	na	$2x10^{-4}$
	WB	$1x10^{-4}$	$2x10^{-4}$	$2x10^{-4}$	$1x10^{-4}$	$2x10^{-4}$
AFC/70-yr	FS	na	$2x10^{-5}$	$2x10^{-5}$	na	$2x10^{-5}$
	WB	$2x10^{-5}$	$3x10^{-5}$	$3x10^{-5}$	$1x10^{-5}$	$2x10^{-5}$
HFC/70-yr	FS	na	$4x10^{-4}$	$4x10^{-4}$	na	$4x10^{-4}$
	WB	$3x10^{-4}$	$5x10^{-4}$	$5x10^{-4}$	$3x10^{-4}$	$4x10^{-4}$
Native American[c,d]						
AFC/30-yr	FS	na	$7x10^{-5}$	$7x10^{-5}$	na	$7x10^{-5}$
	WB	$6x10^{-5}$	$1x10^{-4}$	$1x10^{-4}$	$5x10^{-5}$	$8x10^{-5}$
HFC/30-yr	FS	na	$4x10^{-4}$	$4x10^{-4}$	na	$4x10^{-4}$
	WB	$3x10^{-4}$	$6x10^{-4}$	$6x10^{-4}$	$3x10^{-4}$	$5x10^{-4}$
AFC/70-yr	FS	na	$2x10^{-4}$	$2x10^{-4}$	na	$2x10^{-4}$
	WB	$1x10^{-4}$	$2x10^{-4}$	$2x10^{-4}$	$1x10^{-4}$	$2x10^{-4}$
HFC/70-yr	FS	na	$1x10^{-3}$	$1x10^{-3}$	na	$1x10^{-3}$
	WB	$8x10^{-4}$	$1x10^{-3}$	$1x10^{-3}$	$7x10^{-4}$	$1x10^{-3}$

NOTE: AFC - average fish consumption
HFC - high fish consumption
FS - fillet with skin
WB - whole body
na - not applicable; sample type not analyzed at this site

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 7.5 g/day, or 1 8-oz meal per month (USEPA 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month (USEPA 2000b).

[c] AFC risk based on average consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month (CRITFC 1994).

[e] Site - Waterbody: 56 - Klickitat River; 98 - Deschutes River; 49 - Yakima River; 101 - Umatilla River.

Carcinogenic Chemicals with Estimated Risks at or Above 10^{-5}

Cancer risk estimates vary across populations, consumption rates, and exposure levels by constant factors. Chemicals in rainbow trout with cancer risks at or above 1 x 10^{-5} are shown for the Columbia River Basin Native American population with average fish consumption rates at a 70-year exposure duration; total cancer risks for all chemicals are also shown (Tables 6.4.1 and 6.4.2). Multiplicative factors used to estimate risk at different exposure parameters and target populations are footnoted in the table. In addition, Appendix I shows individual risk estimates for each detected chemical for all the exposure scenarios used in this risk assessment

The three chemicals with excess cancer risks at or above 1 x 10^{-5} were identified for each tissue type and for each site. Seven chemicals had risk at or above 1 x 10^{-5} for rainbow trout fillet: adjusted Aroclors, PCB 126, PCB 118, PCB 156, DDE, 2,3,7,8-TCDD, and 1,2,3,7,8-PeCDD. In addition to these seven chemicals, arsenic and PCB 105 have risk at or above 10^{-5} in whole body samples. PCB 126 had the highest risk estimate for all sites and tissue types except whole body samples at Site 56, for which arsenic was highest.

Adjusted Aroclors had the second or third highest risk estimate for all sites and tissue types except whole body samples at Site 49. Aroclor 1254 was the only individual Aroclor detected and used in the adjusted Aroclor calculation for all sites and tissue types except for whole body samples at Site 101, for which only Aroclor 1260 was detected and used.

Table 6.4.1 Chemicals with cancer risks at or above 1 x 10^{-5} in Columbia River Basin Native American population at average fish consumption and 70-year exposure duration in rainbow trout, whole body

Rainbow Trout - Whole Body					
		Site			
	Chemical	49	56	98	101
PCBs	Adjusted Aroclors	2E-05	2E-05	3E-05	2E-05
	PCB 105			1E-05	
	PCB 118	2E-05		2E-05	
	PCB 126	4E-05		8E-05	3E-05
	PCB 156	2E-05	2E-05	2E-05	
Dioxin/furans	1,2,3,7,8-PeCDD	3E-05		2E-05	2E-05
	2,3,7,8-TCDD	2E-05			
Pesticides	DDE	2E-05			
Inorganic	Arsenic		7E-05		1E-05
	Total Cancer Risk for All Chemicals	2E-04	1E-04	2E-04	1E-04

Table 6.4.2 Chemicals with cancer risks at or above 1 x 10^{-5} in Columbia River Basin Native American population at average fish consumption and 70-year exposure duration in rainbow trout, fillet with skin

		Rainbow Trout Fillet w-skin	
		Site	
	Chemical	49	98
PCBs	Adjusted Aroclors	2E-05	2E-05
	PCB 118	1E-05	2E-05
	PCB 126	3E-05	6E-05
	PCB 156	1E-05	1E-05
Dioxin/furans	1,2,3,7,8-PeCDD	3E-05	2E-05
	2,3,7,8-TCDD	2E-05	
Pesticides	DDE	1E-05	
	Total Cancer Risk for All Chemicals	2E-04	2E-04

NOTE: na - not applicable; indicates that this tissue type was not measured at this site.

A blank indicates that cancer risk for this chemical was not at or above 10^{-5} for this tissue type at this site.

To estimate risk levels for general public AFC 30-year exposure, divide the cells in this table by 19.64.

To estimate risk levels for general public HFC 30-year exposure, divide the cells in this table by 1.03.

To estimate risk levels for Native American AFC 30-year exposure, divide the cells in this table by 2.34.

To estimate risk levels for Native American HFC 30-year exposure, divide the cells in this table by 0.38.

To estimate risk levels for general public AFC 70-year exposure, divide the cells in this table by 8.43.

To estimate risk levels for general public HFC 70-year exposure, divide the cells in this table by 0.44.

To estimate risk levels for Native American AFC 70-year exposure, divide the cells in this table by 0.16.

[a] Site - Waterbody: 56 - Klickitat River; 98 - Deschutes River; 49 - Yakima River; 101 - Umatilla River.